PRODUCT ENGINEERING

JUNE, 1939

LOWERING PROCESSING COSTS

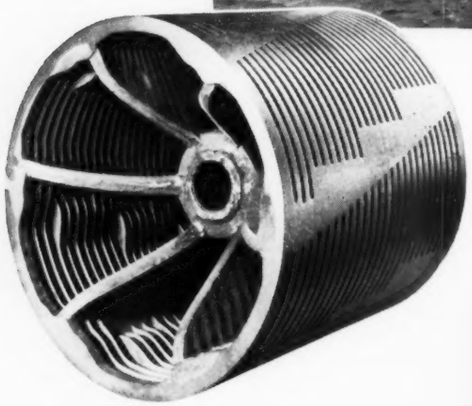
. . . on GOLD, SEWAGE *and* PAPER PULP

. . . with NICKEL CAST IRONS

MIRROR-SMOOTH this 108,000 lb. drier shell presses moisture from paper pulp. To assure uniformity in this casting, 12 ft. in diameter and 18 ft. overall length, Allis-Chalmers Mfg. Co., Milwaukee, added 1% Nickel. This Nickel cast iron developed a dense, close-grained structure throughout, which, together with its uniformity and machinability, makes it ideal for such applications as this, where a very smooth finish is required.

*Ni-Resist—Reg. U. S. Pat. Off. by The International Nickel Company, Inc. — #278,180

*Ni-Hard—Reg. U. S. Pat. Off. by The International Nickel Company, Inc. — #281,986



LASTS 10 TIMES LONGER. In one service test, Ni-Resist,* the special corrosion-resistant Nickel cast iron, withstood acids and organic compounds encountered in raw sewage 10 times longer than plain iron. To cut processing costs in modern sewage disposal plants, this Comminutor grinder shell is cast from Ni-Resist for the Chicago Pump Co. These precision castings, which withstand abrasive wear stoutly as they do corrosion, were produced by the Challenge Foundry Co., Batavia, Illinois.

GOLD MINE "IN THE BLACK." Even in gold mines, operating costs must be kept down. Ball mill liner costs were *halved* when the Wendigo mine in Kenora, Ontario, used Ni-Hard,* an exceptionally hard and wear resistant Nickel cast iron, for liners in their ore grinding mill. These liners, cast by the Vulcan Iron Works, Winnipeg, handled more than *twice* the tonnage reached by previous liners of an unalloyed material. Reduce processing costs by specifying Nickel cast irons for hard jobs in your plant. For practical information about money-saving applications of Nickel alloyed materials in your industry, please write to the address below.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.

PRODUCT ENGINEERING

VOLUME 10 JUNE, 1939 NUMBER 6

What's Coming—Much has been written about "molded plastics" airplanes but according to aeronautical engineers and plastics manufacturers, the reports are "highly exaggerated." So we assigned R. R. Wiese, western editor of *P.E.* to investigate and report. His seven years' experience at the Naval Aircraft Factory in Philadelphia, where his duties included materials testing, made him feel right at home in this assignment. His article "Plastics in Aircraft" will be the lead article in the July number.

The World of Tomorrow is attracting world-wide attention in its popular portrayal of the future. But the real world of tomorrow is in the minds of scientists and is being reared in research laboratories. Things that new scientific theories promise for the future, in the light of past performance, will be the subject of another article in July *P.E.*

Other subjects will include chemical coloring, design of torsion springs, Airfoam rubber and its applications, and new mercury switches.

* * *

Cover Picture—Studebaker's new, lightweight, low-priced car, product of four years' research in marketing and design.

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Published monthly. Price 35c a copy. Subscription rates — United States, Canada, Mexico, Central and South American countries $3 a year. All other countries, $5 a year or 20 shillings. Entered as second-class matter August 21, 1936, at Post Office, Albany, N.Y., under act of March 3, 1879. Printed in U.S.A. Publication Office, 99-129 North Broadway, Albany, N. Y. Editorial and Executive Offices, 330 West 42d Street, New York, N. Y.

Branch Offices: 520 North Michigan Avenue, Chicago; 883 Mission Street, San Francisco; Aldwych House, Aldwych, London, W. C. 2; Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Atlanta, Ga. Cable Address: MCGRAWHILL, New York. Member A. B. P. Member A. B. C.

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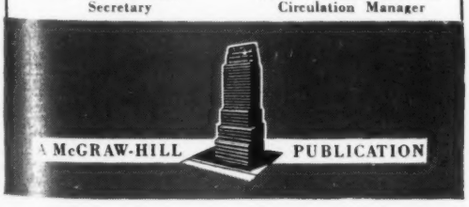

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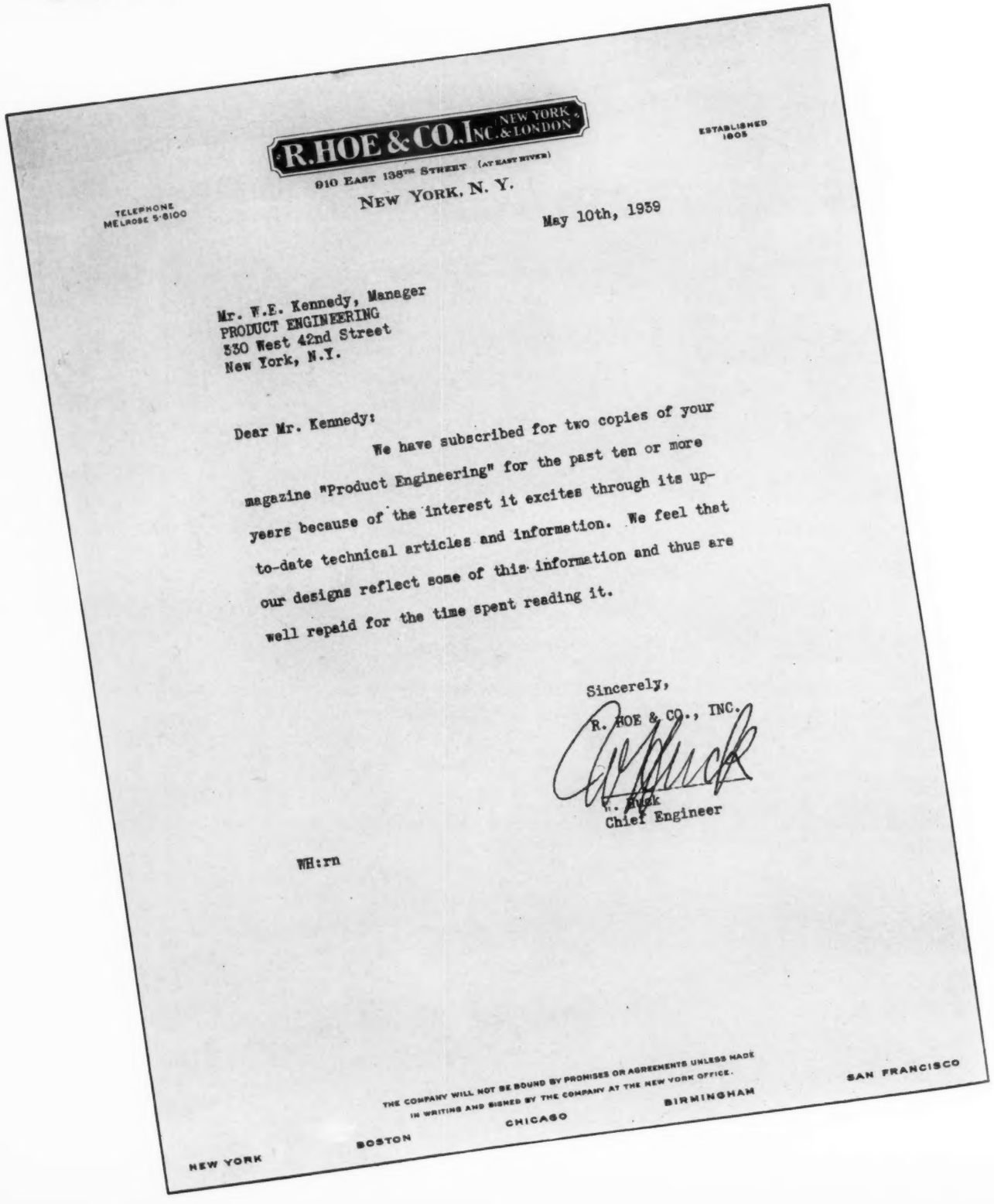
"Well Repaid"...



R. HOE & CO., INC. NEW YORK & LONDON

ESTABLISHED 1805

910 EAST 138TH STREET (AT EAST RIVER)

NEW YORK, N. Y.

TELEPHONE MELROSE 5-8100

May 10th, 1939

Mr. W.E. Kennedy, Manager
PRODUCT ENGINEERING
330 West 42nd Street
New York, N.Y.

Dear Mr. Kennedy:

We have subscribed for two copies of your magazine "Product Engineering" for the past ten or more years because of the interest it excites through its up-to-date technical articles and information. We feel that our designs reflect some of this information and thus are well repaid for the time spent reading it.

Sincerely,
R. HOE & CO., INC.
W. Huck
Chief Engineer

WH:rn

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PROMINENT PRODUCT ENGINEERS HAVE FOUND IT PAYS

PRODUCT ENGINEERING

GEORGE F. NORDENHOLT, *Editor*

His Name Was Isaac

The name of the character in this story is purely fictitious. Any similarity to the names of hundreds of persons, living or dead, to whom this episode might apply, is purely a coincidence.

HE was the oldest of many sons and daughters and because times were hard and Isaac had failed repeatedly to be promoted in school, his father commanded him to apply for the position of church sexton, as advertised. The parson was impressed with the husky looking lad of 15 and felt confident that the boy was thoroughly capable of cutting the grass, shovelling the snow and ringing the bell. He gave Isaac the job.

In giving Isaac his final instructions, the minister told him to make a written report daily of things that needed repair, to which Isaac replied that it was impossible for him to do it as he could neither read nor write. So Isaac forthwith lost the job.

In great wrath, Isaac's father upbraided his unscholarly son and gave him a card of collar buttons to peddle on the streets. Soon Isaac returned for more collar buttons to sell and in a few days he was trudging the streets with a tray suspended from his neck, carrying an assortment of safety pins, collar buttons, shoe strings, pencils and similar sundries.

With the passing of time Isaac's business grew to a push cart, a corner stand, a modest store and finally the biggest department store in town. Then Isaac had a great dream. He envisioned his store modernized with a new front, new equipment and complete lines of furniture and clothing. Thus he would attract the trade from the surrounding country which now went to the big city seventy-five miles away.

Isaac's banker was enthusiastic about the plan and urged Isaac to put it into effect at once. To which Isaac remarked that it would require an investment of $100,000 which he would have to borrow.

"We'll lend you the money," said the banker. "I will have the cashier make out the necessary papers at once."

While the papers were being prepared, the banker and Isaac talked of various and sundry things and when the papers were delivered, Isaac was asked to sign. He carefully marked his X in the proper place and when the banker remonstrated Isaac explained that he could neither read nor write.

"What!" exclaimed the banker. "You, the biggest merchant in this whole county and you can neither read nor write? Isaac, if you could read and write you'd be the biggest merchant in the whole United States."

"Nay, nay," protested Isaac. "If I could read and write I'd be a church sexton."

Soon after the technical schools have graduated their thousands during this month of commencements, it will befall the lot of many engineers to initiate these embryos of the profession into the intricacies of the world of industry. And there may be some of these beginners whose horizons extend no further than Newton's laws of motion, the principles of thermodynamics and the twenty-seven basic formulas of integral calculus. Being well-possessed of these powerful tools of engineering, and proud of their possession, as he should be, the recent graduate may permit his enthusiasm to becloud the fact that business can only exist by making money.

Such young men should be made to realize that a formal education is merely a tool to be used with intelligence while success and happiness can be gained only by diligent application to master the intricacies of business and by giving deep thought to the complexities of human relations. For the answers to this last problem one can suggest nothing better than the pithy words spoken about two thousand years ago from a mountain in a far-off country.

Isaac could neither read nor write, but he had the answers.

STUDEBAKER'S CHAMPION

FOUR YEARS AGO, seven top-ranking engineering and merchandising executives of the Studebaker Corporation—Paul G. Hoffman, president; Harold F. Vance, chairman of the board; George D. Keller, vice-president in charge of sales, C. K. Whittaker, president of Studebaker Pacific; R. E. Cole, vice-president in charge of engineering; R. A. Vail, vice-president in charge of manufacturing, and W. S. James, chief engineer—met to take the first step toward the production of a new automobile to compete in the same market as the "Big Three." Armed only with an idea—that of producing a soundly-engineered low-priced car styled in good taste and inexpensive to operate and maintain—these men started literally with a blank sheet of paper to create the recently announced "Champion."

Reasoning that "in greatness there is always weakness," their primary problem was to detect where the weakness of the Big Three lay—whether in design, manufacture or marketing of their "lowest-price" cars. This weakness certainly would not lie in manufacturing, because that is the most powerful weapon of the "Big Three"—mass production with its attendant economies in purchasing and manufacturing operations. And as to marketing advantages, the smaller automobile manufacturer does not labor under any appreciable handicap. But how about engineering design? It has long been common knowledge that General Motors and Chrysler design their cars in the different price classes so that some of the parts are interchangeable. Ford is said to do the same thing, though to a lesser extent. It is common knowledge to any engineer that when parts for machines of different ratings are designed for interchangeability, numerous compromises in design must be made. Such inter-make, interchangeable parts, therefore, cannot represent the best in their design and by that same token the complete machine cannot be the ultimate in its design.

It was relatively easy to determine which parts of the cars of the "Big Three" were designed for use in each of a number of different models or makes. Tabulation of such parts ranged from engine block castings and body sheets to springs and spark plugs.

The next problem, then, was to determine the advantages that might be obtained if each part of this contemplated "lowest-price" Studebaker were designed solely for the single purpose for which it was to be used; that is, without the restrictions imposed by its application to a number of cars of different design. For example, what would be the advantages of a cylinder block designed, cast and machined for a given specific engine, and that engine only? The cylinder walls could be a minimum because extra thickness would not have to be allowed to permit boring to a larger diameter for use on a heavier car of another make or model, and this in turn would permit a lighter engine slightly more compact in size. In a similar manner, numerous other advantages were obvious. But this analysis was not the final answer.

Assuming that a great many design improvements over existing "lowest price" cars were possible, would the sum total of improvement be sufficient to represent an outstanding market value; would they make possible a design that would command the attention of the American automobile buyer; would they convert prospects to owners?

Here was a marketing problem that posed questions which could be answered only by the American automobile buyers. Were they entirely satisfied with the "lowest price" cars then available? How

much importance did they attach to miles per gallon, tire mileage, weight, speed, comfort, safety, low-cost maintenance, appearance, and similar factors?

Trained investigators sent out to talk to the automobile owners covered the whole United States to question people in all the income brackets. This survey gave the answers to the marketing questions, confirming the United States census figures that almost 90 per cent of American automobile owners have a hard time "making ends meet." And, as revealed by the Studebaker surveys, their first consideration is the cost of buying and operating the car. The urgent demand was for a low-price car economical to operate and maintain, but having all the desirable features of a medium-priced car—speed, pick-up, comfort and, above all, appearance.

Engineers then began working at a rapid pace. Hand in hand with the design developments, production methods were planned and laid out, and orders were placed for the development of the necessary machine tools and special equipment. The engineers questioned everything that might add a penny to the cost of the car or to its upkeep and operation. "Money-saving for the car owner" became the slogan of the entire Studebaker organization. Their aim was to produce the most remarkable economy car that the American public had ever been offered—but a car that did not sacrifice traditional high quality or tested safety. Studebaker originated instead of imitating or duplicating; designed a new car instead of redesigning an old car.

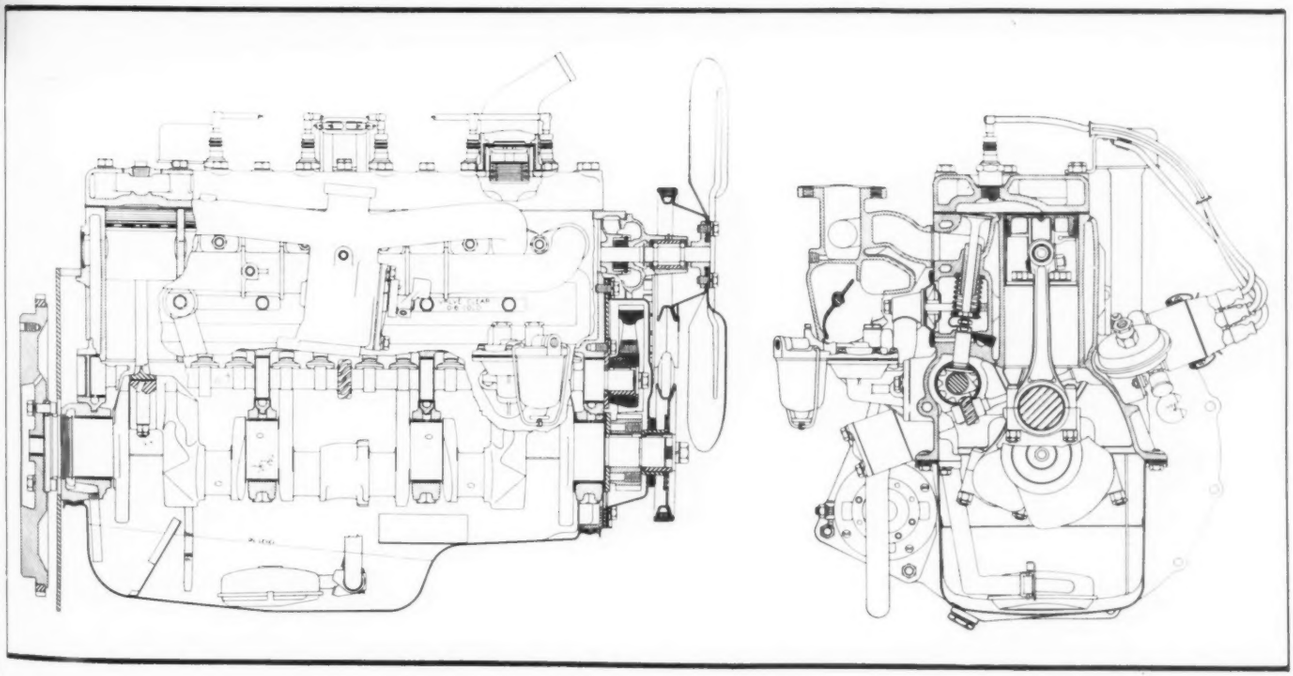
Then, to make certain that this new Champion, as it had been christened, would have all the earmarks of a quality car and an appearance that would compel attention. Studebaker commissioned Raymond Loewy and his assistant Virgil Exner to style the new car. These men, working in cooperation with the Studebaker engineers, produced a design that is roomy, comfortable and distinctive.

In its appearance, the Champion emphasizes its single-purpose design. Front ends, grille work for the wind-tunnel areas, and trim, hood and fenders, all have a singleness of line and contours, and appear as an ensemble, not as a group of individual units. The headlamps are recessed into the fenders. The broad, veed windshied not only adds to the modern appearance of the car, but affords good vision for the driver.

After spending four years and many million dollars on the task, Studebaker has introduced the Champion—a notable engineering accomplishment—the answer of the Studebaker engineering organization to the question "Can it be done?"

The pictures and captions on this and the following pages describe a few of the outstanding design features of the new Studebaker Champion. Evaluation of the engineering ingenuity and design skill that created this car must be left to the reader's imagination.

THE POWER PLANT



The Champion engine, rated at 21.6 *S.A.E.* hp., is a six-cylinder type with a bore of 3 in. a stroke of 3⅞ in. and a displacement of 164.3 cu.in. Compression ratio of 6.5 to 1, without the use of premium gasolines, is attained by good combustion chamber design, the type of spark advance control, good vapor distribution through improved manifold design and automatic valve control of intake mixing temperature. A number of ingenious design features shortened the engine. Because the car is lighter than competitive models, the engine has less displacement, thus the bore diameter is smaller. Valves and ports were carefully positioned for compactness, yet water passages were incorporated completely around each valve seat. The water pump, compact in design, is recessed in the cylinder block. Since the design throughout emphasized light weight construction without sacrifice of strength, inertia of reciprocating parts was minimized, and it was found that there was no appreciable torsional disturbance even without the vibration damper, so it was discarded. Thus the length of the power plant was further reduced. Engine operating smoothness is also aided by three point suspension in rubber. The camshaft is driven by a large Celoron gear. A helical-gear oil pump, driven from the camshaft, delivers oil under pressure to the main bearings and through the drilled crankshaft to the connecting rods; then through escapement holes in the connecting rods to the cylinder walls, pistons, piston pins and rings, camshafts, timing gears, valve tappets and valve mechanism. Oil conduits throughout the engine are short, reducing the danger of plugged oil passages. Oil is directed under pressure through drilled holes in the block.

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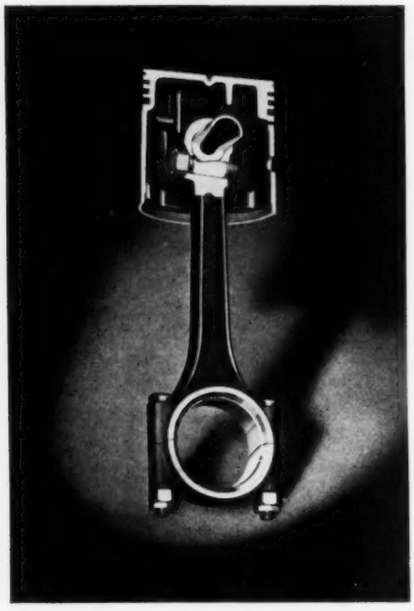
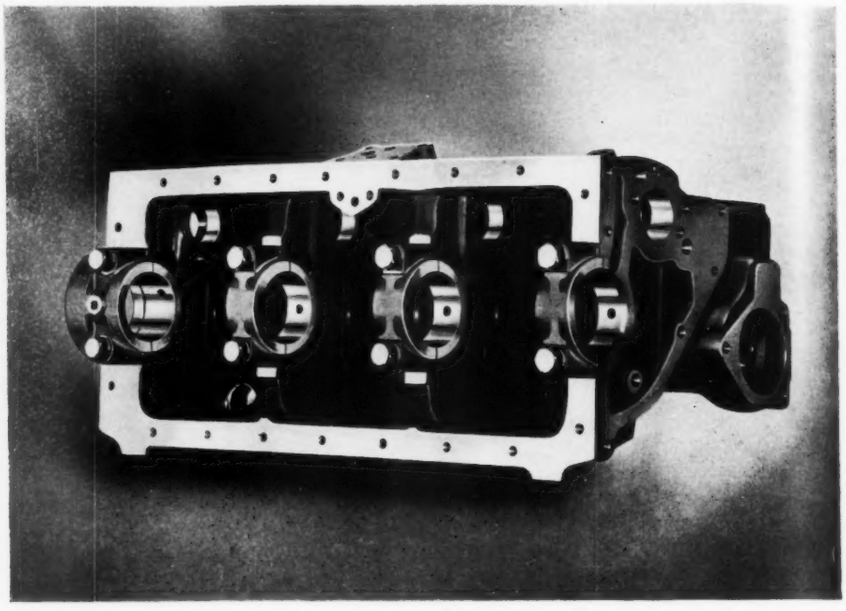
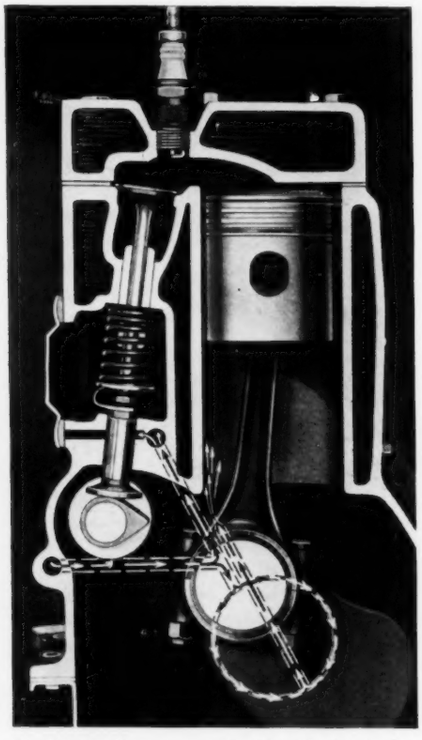
STUDEBAKER'S CHAMPION—Power Plant *Continued*



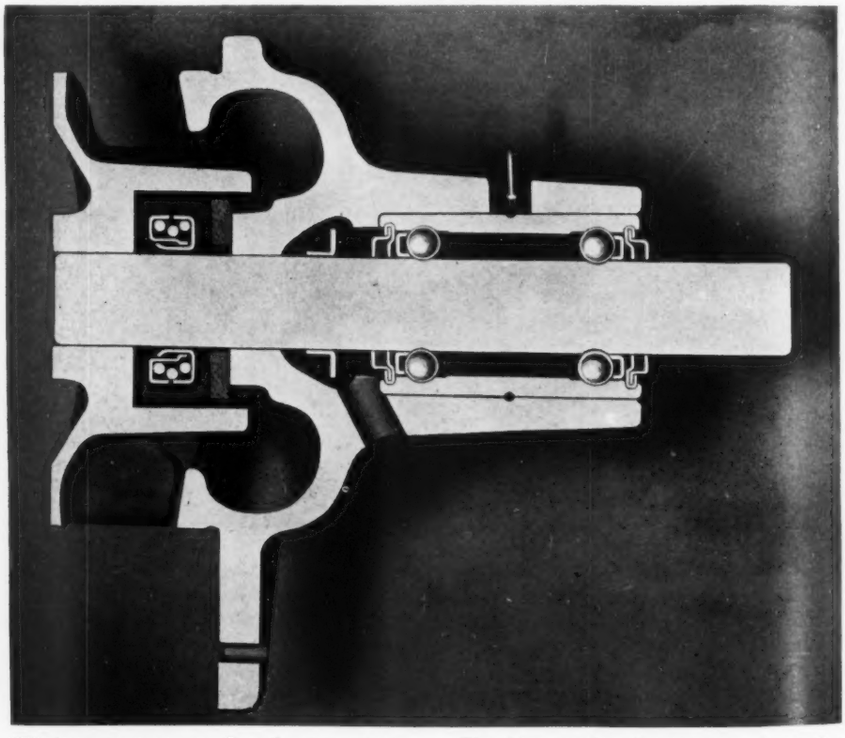
Connecting rod analysis: C, 0.35-0.45 per cent; Mn. 1.35-1.65 per cent; S max., 0.05 per cent; P max., 0.045 per cent; Si min., 0.15 per cent. Tapered lock screw serves as wedge to anchor the piston pin in the rod.



Large diameter bearings give great crankshaft stiffness. For equal bearing area, an increase in bearing diameter allows a reduction in width, but the bearing width was not reduced. Hence the bearing area per cu.in. of piston displacement is higher, resulting in longer life as well as higher factor of safety. All main and connecting rod bearings are interchangeable, steel-back, babbitt-lined type. Note heavy ribbing used in motor block casting.

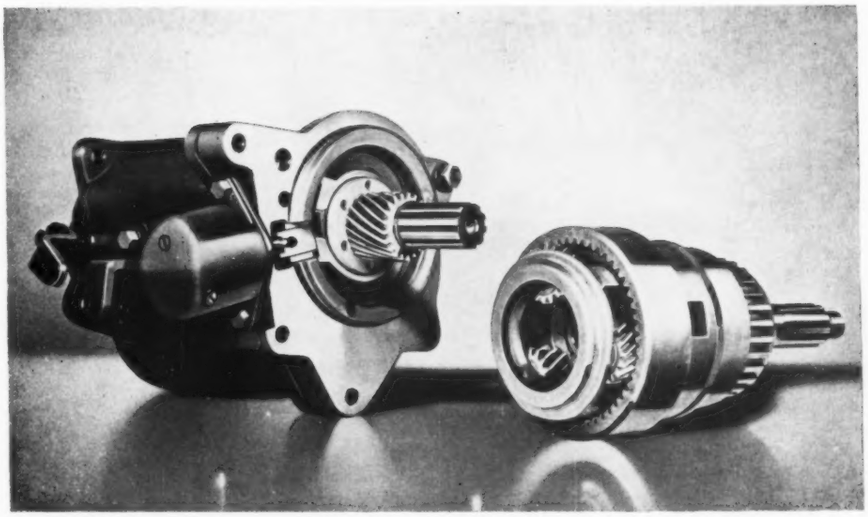


Full-depth water jacketing of the cylinders gives maximum cooling. Pressure lubrication to the valve tappets and cylinder walls is through the drilled holes. Oil leakage is held to a minimum by strong, gasketed, valve tappet covers, and by front and rear crankshaft seals. In the crankcase is a floating oil screen.



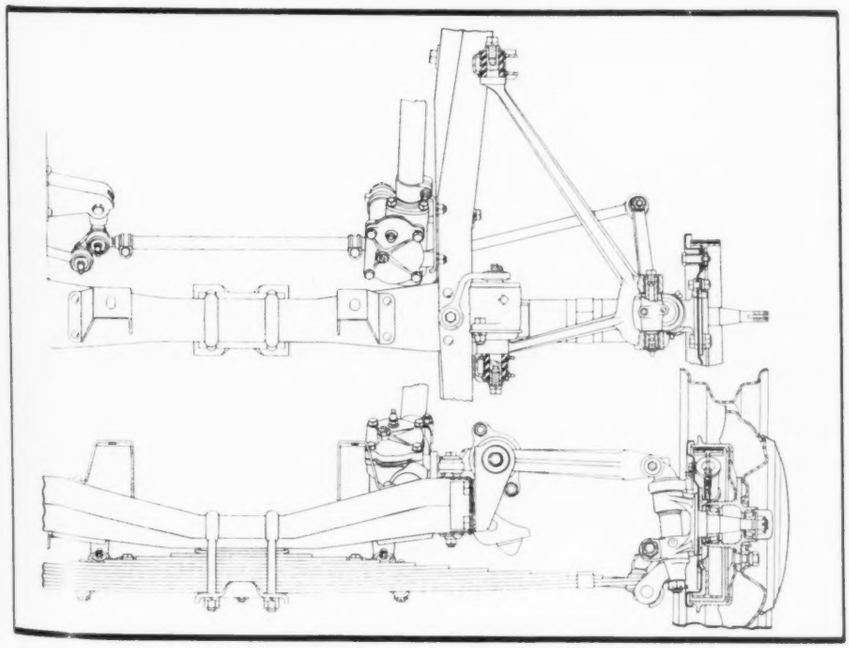
Water pump seal, of composition rubber, recessed in the hub of the water pump impeller, is grooved on front and rear faces for better sealing, and is spring loaded. Rearward face contacts the impeller and forward face contacts a fiber composition washer, thus sealing against leakage around the shaft at these points. The fiber washer has tongues fitting into notches in the impeller hub, causing the impeller, seal, fiber washer, and shaft to rotate together. Wear is compensated by expansion of the water seal spring. The seal itself does not wear since it does not rotate relative to any of the parts which it contacts.

Over-drive transmission is similar to that used on previous models with the exception that an additional pawl controlled by a solenoid can act to unlock the sun gear of the over-drive gear train, thus permitting a direct drive through the transmission main shaft instead of through the over-drive gear train. The control operation is as follows: When the foot accelerator pedal is depressed beyond the wide-open throttle position, a lever in the throttle mechanism closes a switch which actuates a relay that in turn places battery voltage across the solenoid. The energized solenoid attracts a small disk which shuts off the ignition, thereby unloading the transmission gears and permitting the solenoid plunger to disengage or unlock the sun gear. As the plunger enters the solenoid, the ignition contact is remade. Action is almost instantaneous; the ignition being shut off for about one-fifth second. The solenoid is only energized when the foot accelerator is pushed beyond the wide-open throttle position as described. This will not occur inadvertently under fast driving conditions, as additional foot pressure is required to actuate the switch. Near the end of its stroke the solenoid opens auxiliary contact points, thereby putting resistance in the solenoid circuit so that even if the foot accelerator is held beyond the wide-open throttle position, the continuous current flow through the solenoid windings will be too small to cause overheating and damage to the coil.

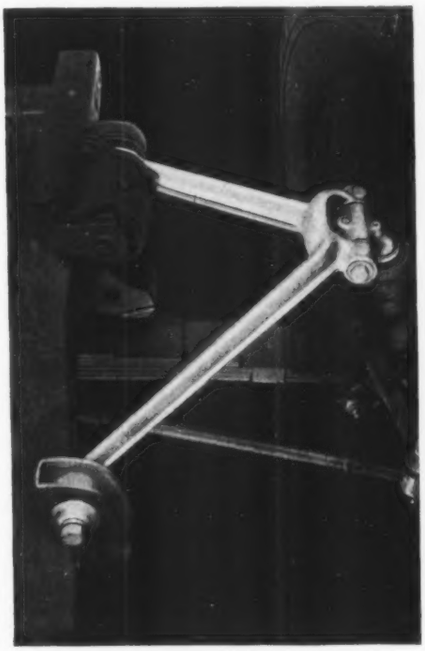


The solenoid plunger is spring loaded, so that as soon as the solenoid is de-energized it again tends to lock the sun gear and return the transmission to the overdrive ratio. It is prevented from doing so by a blocker ring, which will release the lock-up only through reversal of torque reaction produced only when the throttle is released and then depressed. Thus the transmission will remain in direct ratio so long as the drive load is maintained. When the load changes from drive to coast and then back to drive, blocker ring permits the pawl to again lock the sun gear, putting transmission in overdrive ratio. The manner of re-engaging overdrive after entering direct ratio through depression of the accelerator pedal beyond the wide-open throttle position, is similar to overdrive engagement when the car has been brought up to speed from standstill. Overdrive is optional, at extra cost.

PLANAR SUSPENSION



Self-stabilizing independent front wheel suspension in the Champion is similar to that used on other Studebaker cars. It is of interest to note that the inner and outer pivot points of the support arms and front springs have been so located that no sidewise scuffing of tires is possible. The point of contact between tire and road does not change with spring deflection, but wheel camber does change slightly. With the type of steering linkage used, the pivot points on reach rods and springs coincide, thus no wheel twist occurs from spring deflection.



Steering knuckles are supported at upper ends by heavy, forged steel support arms connected to widely separate frame mountings. Rubber mountings at the inner ends of support arms cushion shocks which would otherwise be transmitted to the frame.

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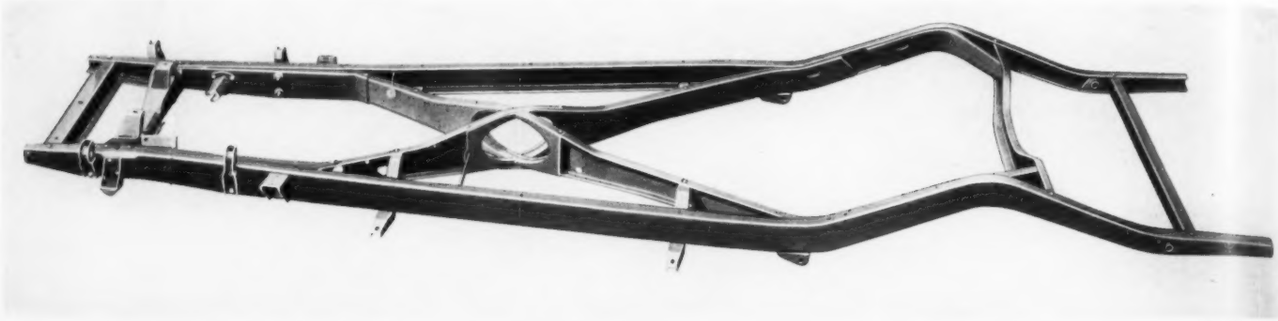
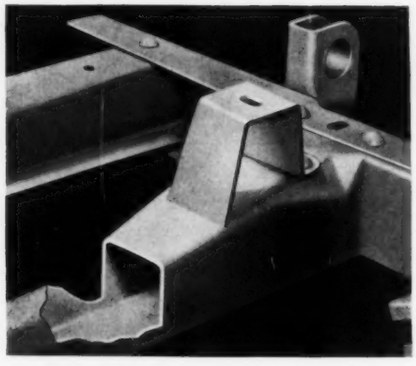
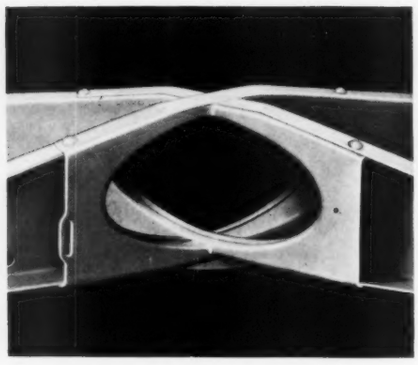
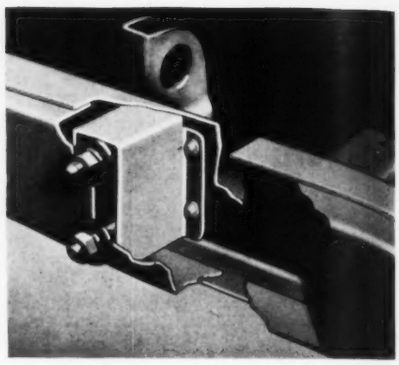
STUDEBAKER'S CHAMPION—Frame and Body Construction *Continued*







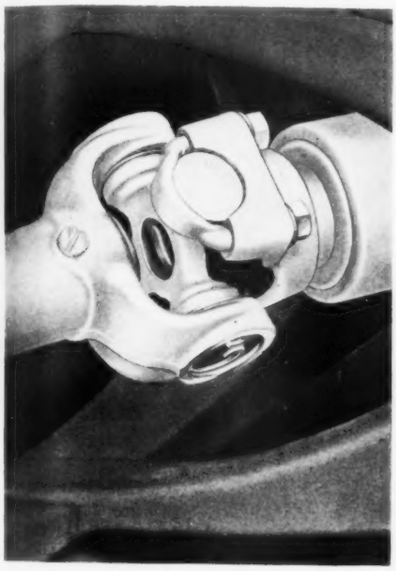


The steel frame is unusually light but it is claimed to be stiffer in proportion to weight than any frame used in a previous Studebaker model. It has an *X*-member without offset at the center, with the center portion a reinforced box section. Side members are of box section from the junction of the *X*-member forward to the front cross members. A maximum depth of $7\frac{53}{64}$ in. is provided for the *X*-member, side members have a maximum depth of $4\frac{1}{8}$ in., and a flange width of $1\frac{3}{8}$ in. Reinforcements are used at frame joints. The all-steel top is supported by box section windshield posts and box section door posts. Rear hinge pillar is of full box construction section, as are sill panels. Roof rail is semi-box section construction. Two box section reinforcements are spot-welded diagonally across the bottom of the floor pan. Door constructions at top and window sides form a box section, with a full inner panel formed and ribbed for greater strength. Rear door has no projecting hinges. One-piece steel top construction includes formed openings for cowl ventilator, windshield and rear window, with welded cowl cross bar which adds rigidity to the construction.

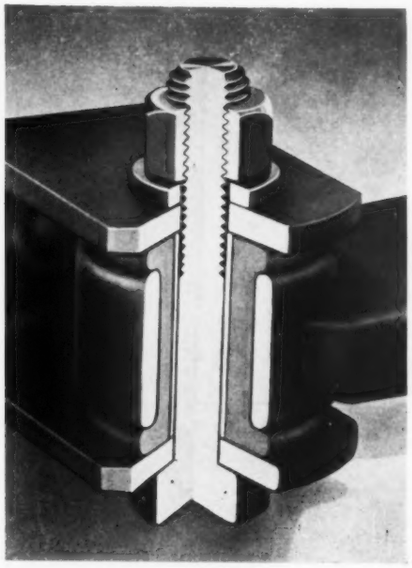
Body insulating and sound deadening. All roof panels are insulated against noise and heat by first spraying a heavy layer of Insulmat sponge-like sound absorbent on the inner surface, bonded directly to the steel. This prevents drumming and rumble by absorbing vibrations that get past the box sections that serve as a vibration dam. Cemented

to the Insulmat is a thick blanket of "Kimsul" cotton-like shredded tissue, impregnated with asphaltum to prevent deterioration from moisture absorption. Dead-air spaces in this material retard heat transfer. The undersides of all floor pans are completely covered with Insulmat to absorb sound and rumble. Inside panels of all doors are sprayed with a layer of anti-resonance insulation material. The front compartment dash lining is covered with three layers of dry felt insulation and a layer of embossed insulation fiber board, to shut out engine heat and noise. The inside of the rear lower quarter and back panels above wheelhouse have a layer of Insulmat bonded directly to the steel panels. The inside of the rear deck door and trunk door panels are sprayed with layers of anti-resonance material bonded to the steel panel. In addition to the underside insulation mentioned previously, thick layers of "Cordex" insulating material, resembling heavy felted asphalt roofing, are applied to the whole steel floor surface inside the body. On top of this, a $\frac{1}{8}$ in. thick rubber mat with $\frac{1}{4}$ in. jute pad is on the floor in the driver's compartment.

MECHANICAL PARTS

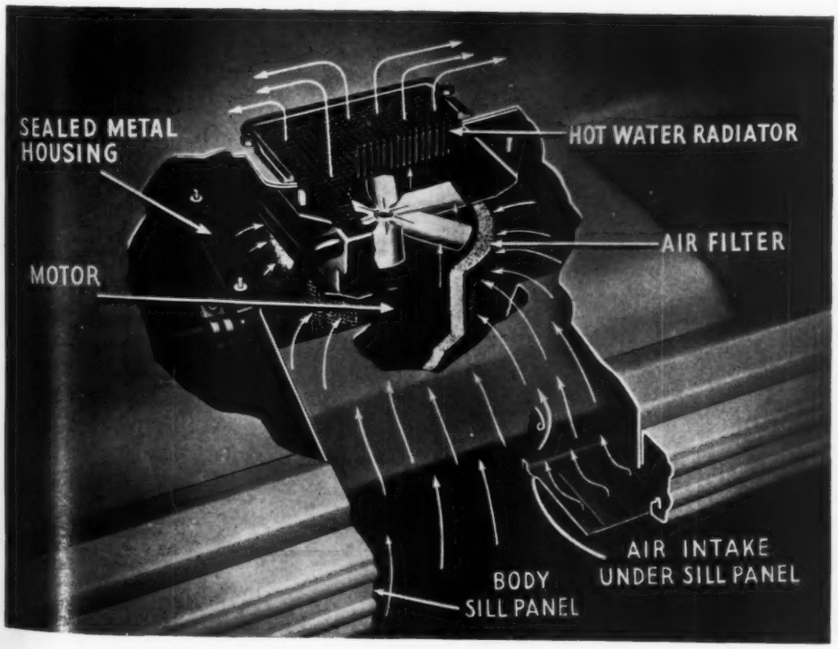


Universal joint in the Champion's propeller shaft assembly is of the needle bearing type.

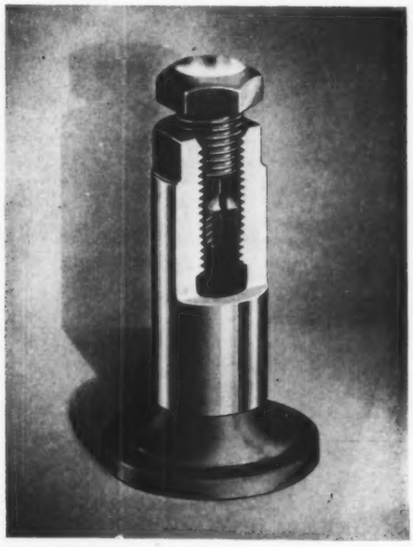


Rear shock absorber links as well as planar support arm anchorage are rubber-mounted.

Steering knuckles are designed with ball and roller bearings to help reduce steering effort.



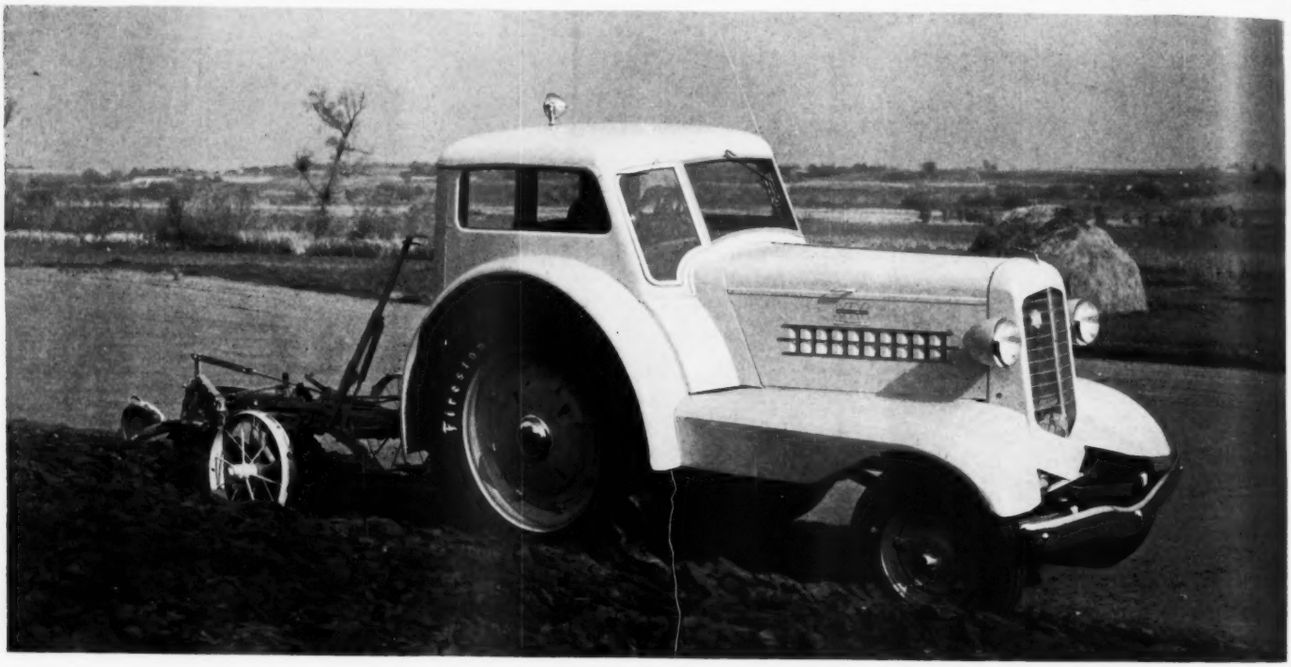
Conditioned air as a deluxe feature is available in the Champion. This is a heating system which draws in outside air, filters and heats it, and distributes it between the front and rear compartments. The unit is designed to fit under the front seat and thus does not reduce the available passenger space. Below the windshield are built-in hot-air vents for defrosting service in cold weather.

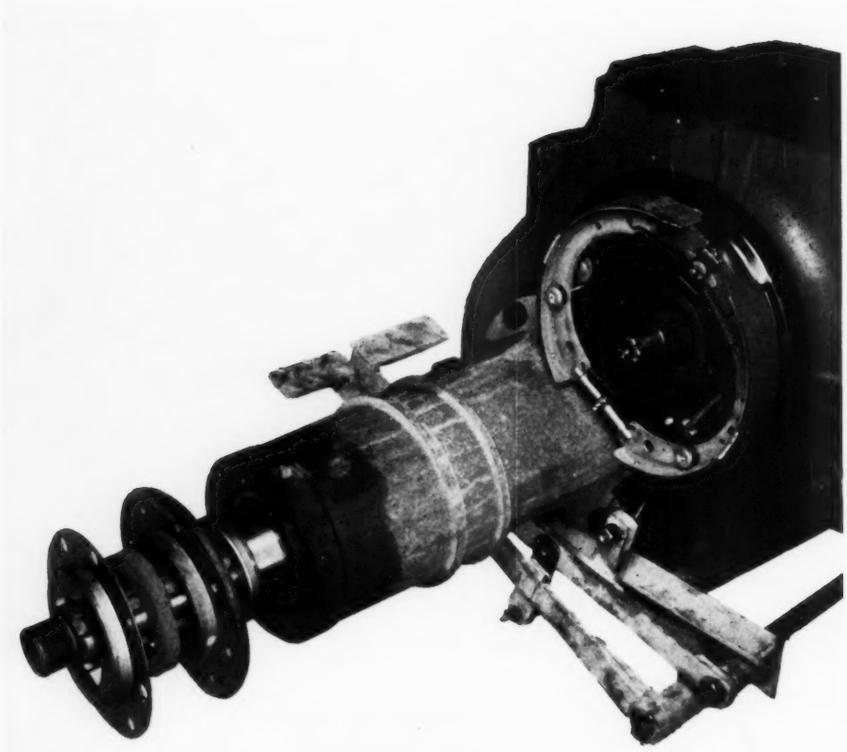


Self-locking tappet screw is machined with two sets of threads with a gap between. The two groups of threads are mismatched 0.07 in. Resulting bind as the second set of threads enter the tappet is sufficient to prevent the screw from turning in service while the machined slot in the screw relieves excess loading on the screw threads.

Modern Designs

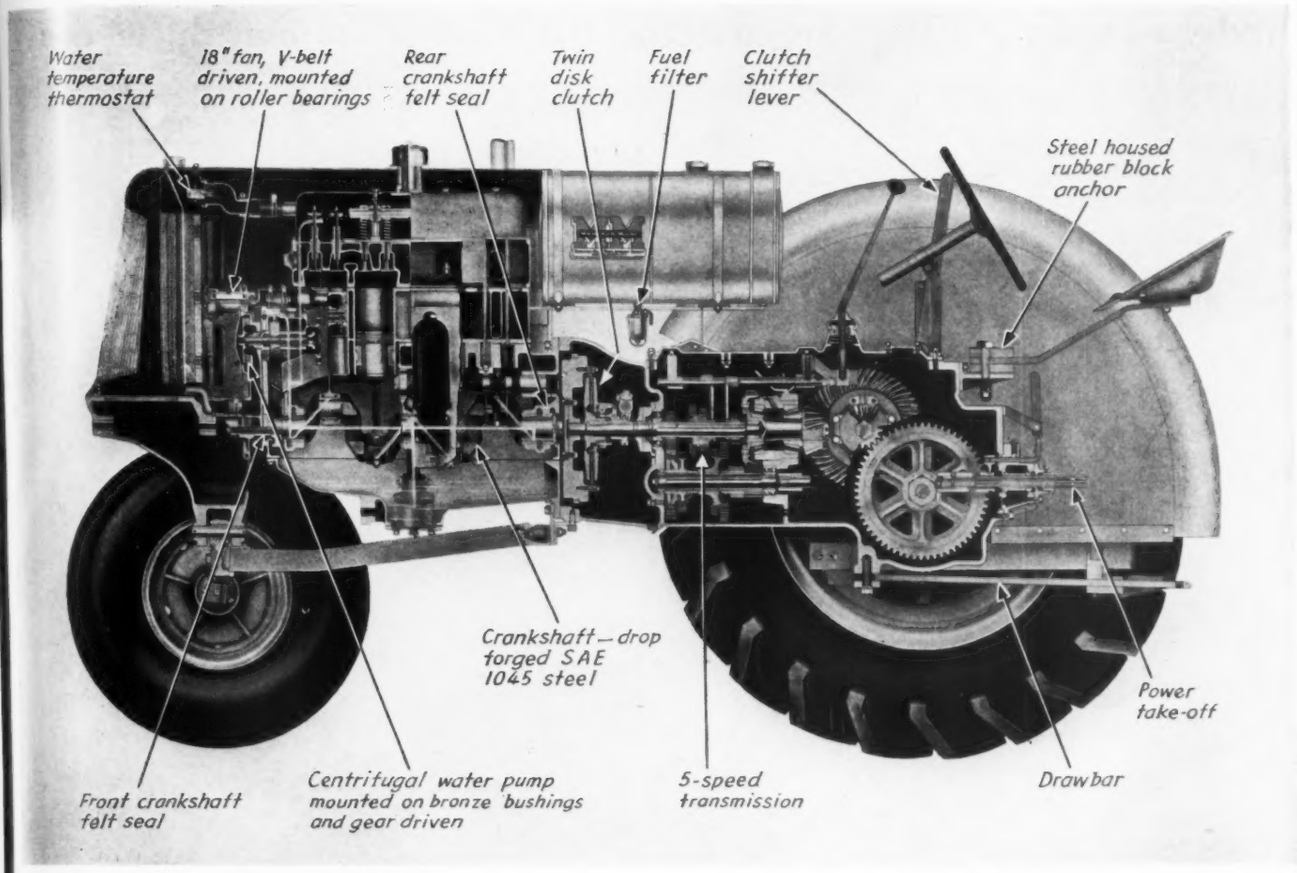
Streamlined Tractor Has Automotive Accessories as Standard Equipment



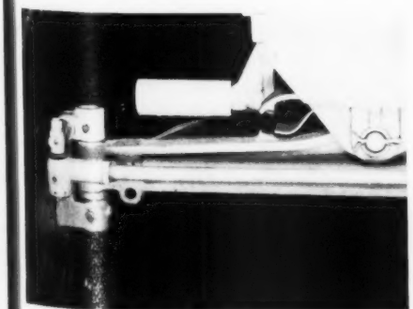


Closed car comfort and all conveniences found in the modern automobile — hence this Minneapolis-Moline tractor is called the Comfortractor. Streamlining, an all-steel cab, safety glass, fenders, bumpers, head and tail lights, electric starting, forced air ventilation are additional features. The fully-inclosed cab, lined with sound-absorbing material, has centrally located instruments, hot water heater and radio as standard equipment. Seats are sponge rubber, imitation-leather covered. The variable speed governor, brakes and clutch are pedal controlled. Trap doors in the cab floor allow operator to adjust drawbar without leaving seat. Tractor speeds up to 40 mi. per hr. are available.

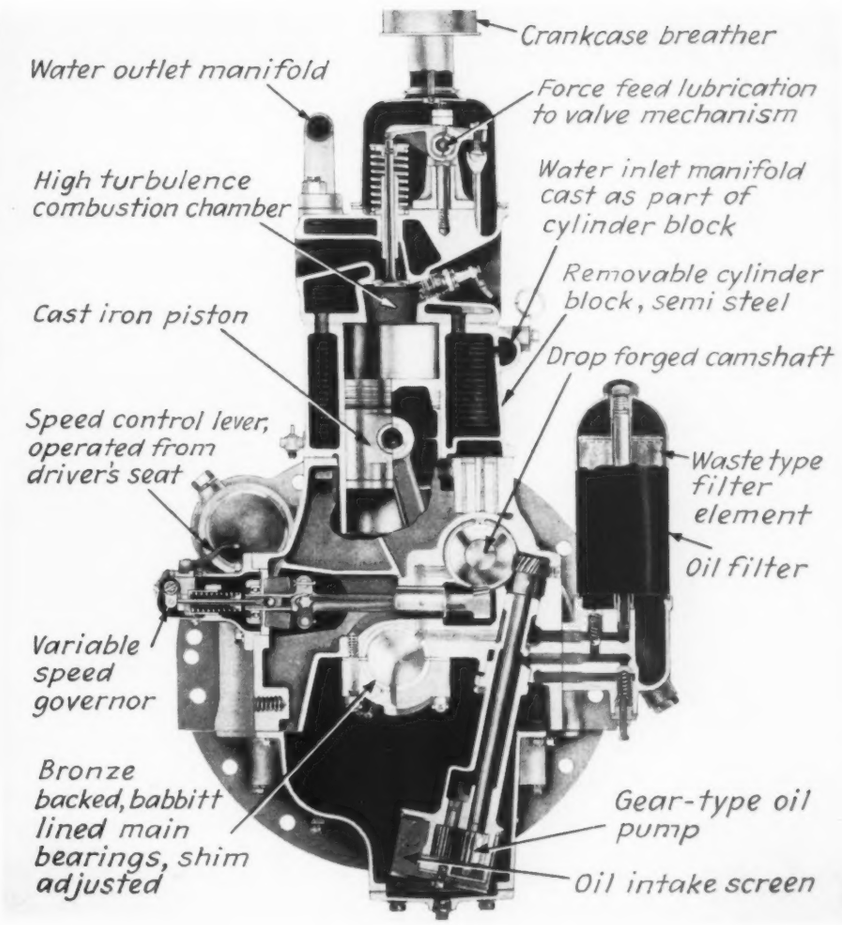
Felt and leather seals are on both front and rear of crankshaft. Further precautions against dirt include an oil filter with an easily replaced waste-type element, a crankcase breather filter, the usual gasoline filter, and an oil wash air cleaner in the carburetor air intake line. Entire inner portion of the transmission is protected by felt seals; oil is retained by leather packings. Gear type oil pump with 5-1/4 gal. per min. capacity supplies forced-feed lubrication to moving parts.


Water temperature thermostat
18" fan, V-belt driven, mounted on roller bearings
Rear crankshaft felt seal
Twin disk clutch
Fuel filter
Clutch shifter lever
Steel housed rubber block anchor
Crankshaft—drop forged SAE 1045 steel
Power take-off
Front crankshaft felt seal
Centrifugal water pump mounted on bronze bushings and gear driven
5-speed transmission
Drawbar

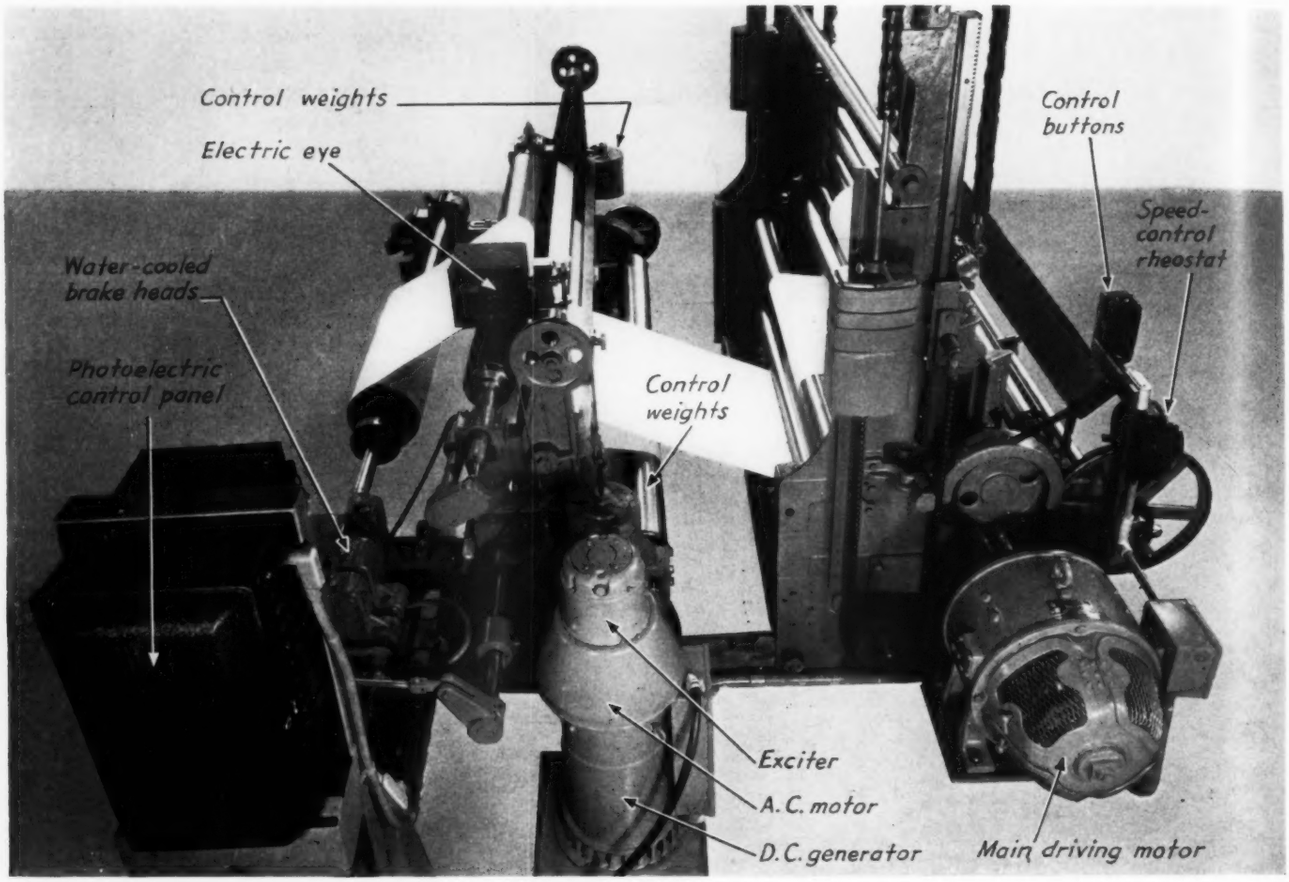
Longitudinal section of the cab-less model showing relative location of main parts. Engine is Minneapolis-Moline four cylinder, develops 39 drawbar hp. Crankshaft is *S.A.E.* 1045 drop-forged steel, heat-treated; connecting rods are *S.A.E.* 1040 drop-forged, heat-treated steel; camshaft is drop-forged *X*-1020 steel, case-hardened. Bearings are bronze-backed, babbitt-lined. Tractor speed is controlled by manipulation of variable-speed governor, throttling engine between 300-1275 r.p.m. Governor is fully-inclosed and automatically lubricated. Belt pulley mounted on left side of engine operates at 2980 ft. per min. with engine speed of 1275 r.p.m. Front fender is easily demountable.



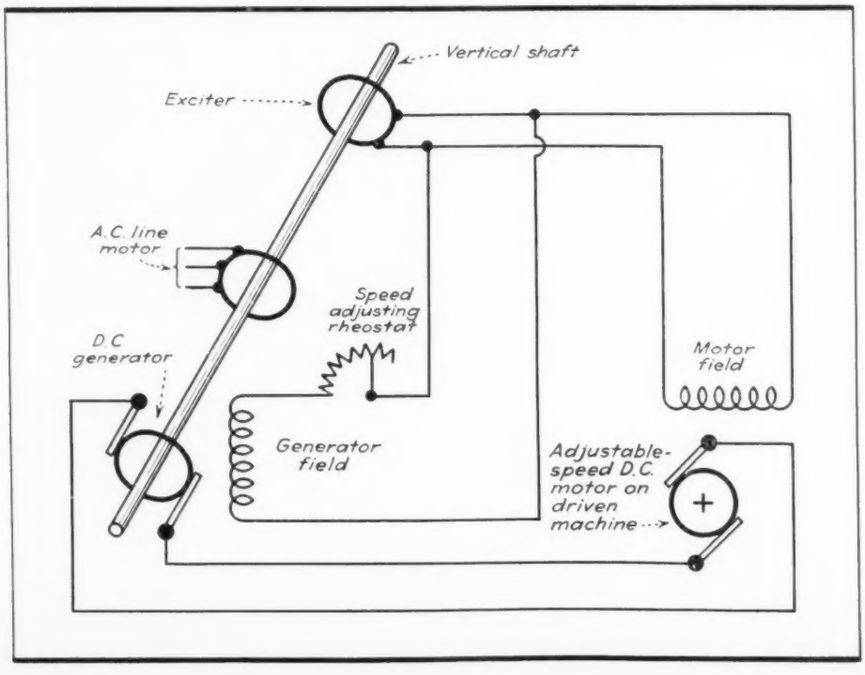
Front axle of malleable iron is equipped with forged steel recoil and counter-recoil oil springs, extra heavy-duty Timken thrust bearings. The H-section axle is pivoted at the center.


Crankcase breather
Water outlet manifold
Force feed lubrication to valve mechanism
Water inlet manifold cast as part of cylinder block
High turbulence combustion chamber
Removable cylinder block, semi steel
Cast iron piston
Drop forged camshaft
Speed control lever, operated from driver's seat
Waste type filter element
Oil filter
Variable speed governor
Bronze backed, babbitt lined main bearings, shim adjusted
Gear-type oil pump
Oil intake screen

Modern Designs—High-Speed Slitter Has Electric Variable-Speed Drive

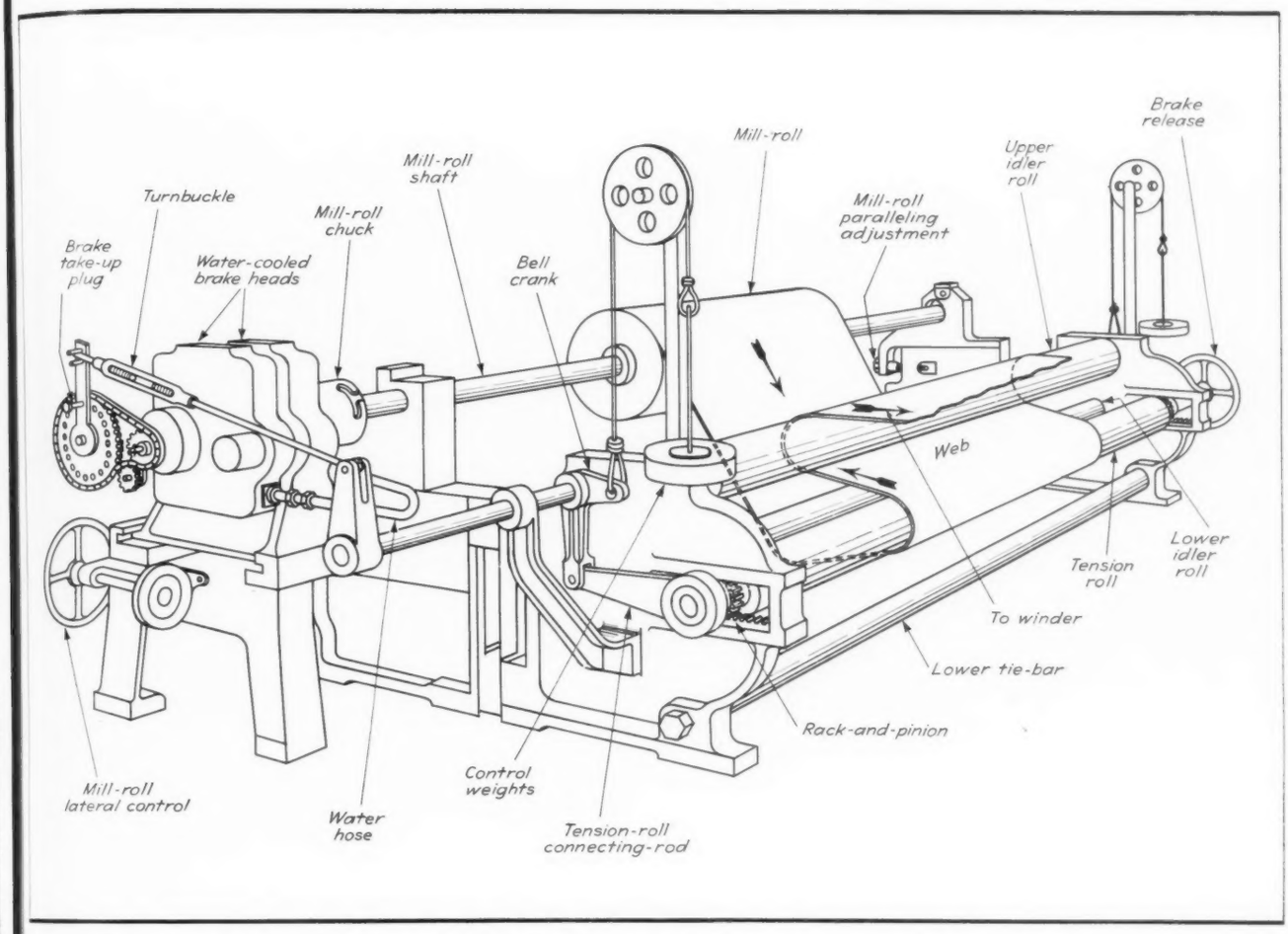


Adjustable-speed drive, constant web tension control and automatic side register control are features of the Camachine 10, a new 62 in. high-speed slitter built by the Cameron Machine Company. William M. Stocker, chief engineer. The machine is equipped with anti-friction bearings throughout and is driven by a 7½ hp. Reliance d.c. motor direct-connected to the drive gear. Variable speed is obtained through a Reliance type V*S control unit consisting of a separately-excited variable-voltage d.c. generator driven by an a.c. motor. A photoelectric-mechanical hook-up maintains side register control, and a counterweighted linkage is used to keep web tension constant at any predetermined amount.

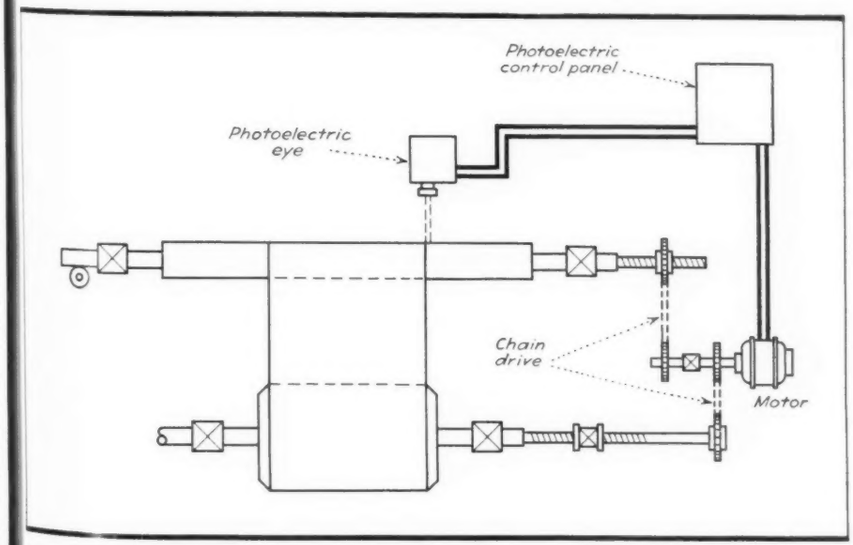


Speed-changing combination, shown in schematic hook-up, was developed by Reliance to provide an economical means for varying operating speeds over as much as 12 to 1 range in small installations where a.c. only is available. The control is built as a packaged unit occupying a minimum of floor space, and consists of an a.c. motor, an exciter and a d.c. generator, all mounted on the same vertical shaft. All mechanical and electrical parts are similar to those handled regularly in plant maintenance work.

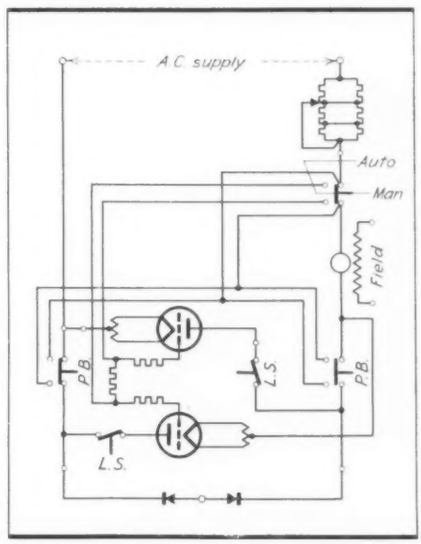
Generator output voltage is varied by impressing resistance in the separately-excited generator field; this, in turn, varies the speed of the d.c. motor connected across the generator. The drive is available for 3 phase, 60 cycle, 220, 440, or 550 volt supply, in sizes from 1 to 15 hp. Control unit and speed-changing rheostat can be located at any convenient point near or remote from the driven machine. With this new, compact speed-changing unit, any type of d.c. driving motor can be specified.



Web tension is varied by changing the amount of counterweight. The floating tension roll rotates on roller bearings on a shaft supported on racks and pinions at the ends. The shaft, free to move forward and back, always remains parallel with the idler rolls. Control weights, through the bell-crank and connecting rod, tend to pull the tension roll forward and also tighten the brake through the turnbuckle and chain mechanism. The pull of the web tends to pull the roll backward. The system, therefore, is in balance—when the web slackens, the weights pull the tension roll forward and tighten the brake, increasing the web tension. Should the web become too taut, the opposite will occur.

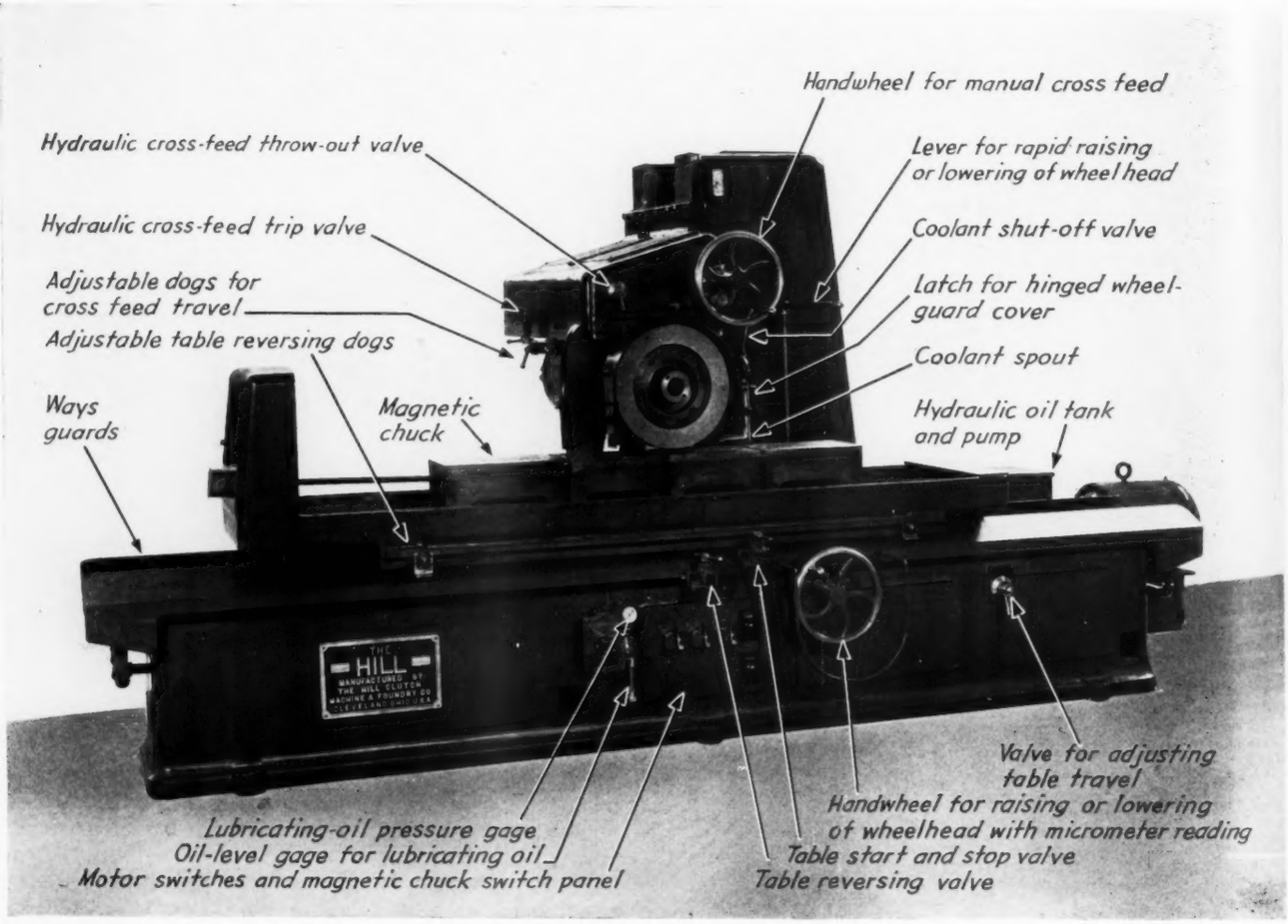


Register control, shown schematically, operates within limits of $\frac{1}{32}$ in. at high speeds, through an electric-mechanical linkage. Should web run off register, the Westinghouse electric eye closes circuit to small motor which by chain and screw mechanism adjusts shaft alignment to compensate for the error.

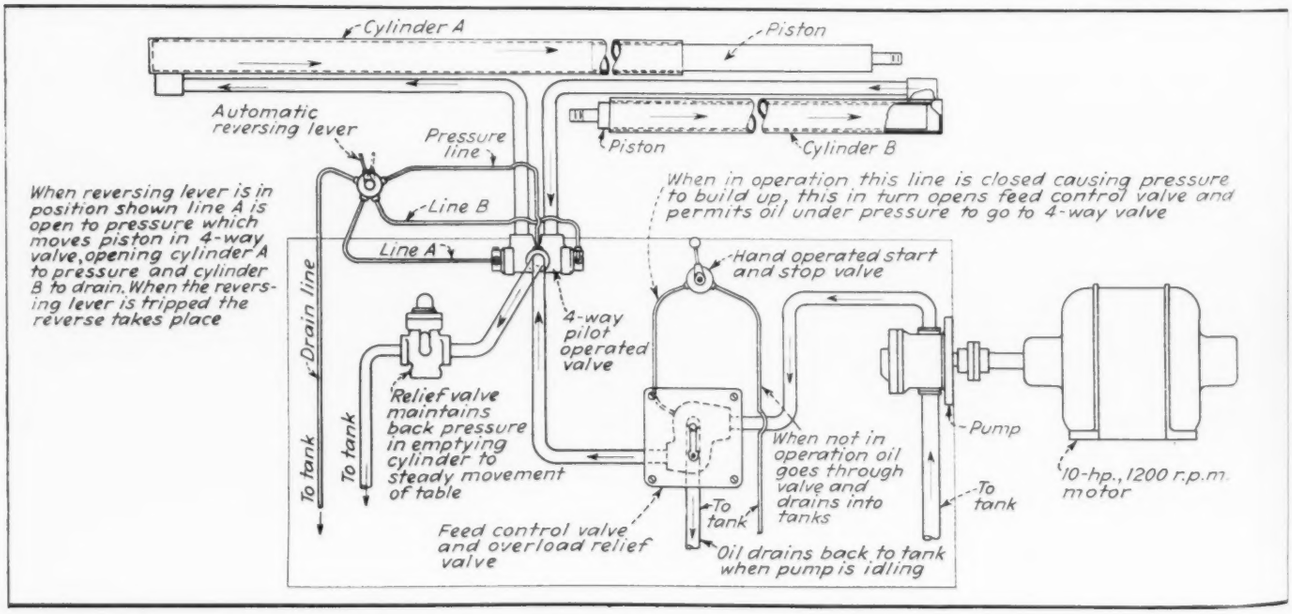


Motor in this linkage is reversed by voltage reversal across armature when current is transferred by electronic means from one tube to other.

Modern Designs—Table Drive and Cross Feed Fully Hydraulic


Handwheel for manual cross feed
Hydraulic cross-feed throw-out valve
Lever for rapid raising or lowering of wheel head
Hydraulic cross-feed trip valve
Coolant shut-off valve
Adjustable dogs for cross feed travel
Latch for hinged wheel-guard cover
Adjustable table reversing dogs
Coolant spout
Ways guards
Magnetic chuck
Hydraulic oil tank and pump
Valve for adjusting table travel
Handwheel for raising or lowering of wheelhead with micrometer reading
Lubricating-oil pressure gage
Oil-level gage for lubricating oil
Motor switches and magnetic chuck switch panel
Table start and stop valve
Table reversing valve

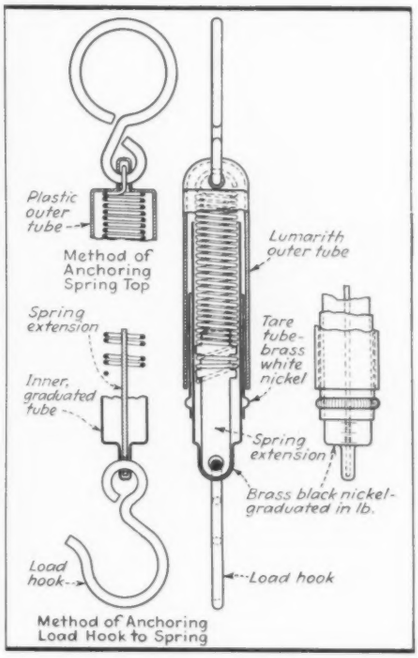
Five motors are incorporated in the horizontal grinder built by the Hill Clutch & Machine Foundry Company. Wheel spindle is driven by a dynamically-balanced 15-40 hp. built-in motor mounted on the end of the spindle. Machine bed, table and column are cast of a high-tensile, pearlitic iron alloy containing nickel and chromium.


Cylinder A
Piston
Automatic reversing lever
Pressure line
Piston
Cylinder B
When reversing lever is in position shown line A is open to pressure which moves piston in 4-way valve, opening cylinder A to pressure and cylinder B to drain. When the reversing lever is tripped the reverse takes place
Line B
When in operation this line is closed causing pressure to build up, this in turn opens feed control valve and permits oil under pressure to go to 4-way valve
Line A
Hand operated start and stop valve
4-way pilot operated valve
Drain line
Relief valve maintains back pressure in emptying cylinder to steady movement of table
To tank
To tank
When not in operation oil goes through valve and drains into tanks
Pump
10-hp., 1200 r.p.m. motor
To tank
To tank
Feed control valve and overload relief valve
Oil drains back to tank when pump is idling

Hydraulic pump, driven by a 10 hp. motor, furnishes pressure to drive table at speeds up to 100 ft. per min. Cross feed, also hydraulic, can be oscillated at a constant feed, or adjustable from $\frac{1}{8}$ in. to 2 in. at each reversal of table for jump feed. Forced-feed lubrication for the tableways and spindle bearings is provided by a pump powered with a $\frac{1}{4}$ hp. motor. Coolant pump motor is 1/3 hp. Rapid traverse for raising and lowering wheel head is motor driven.

Translucent Plastic Adds Sales Appeal to New Pocket Scale

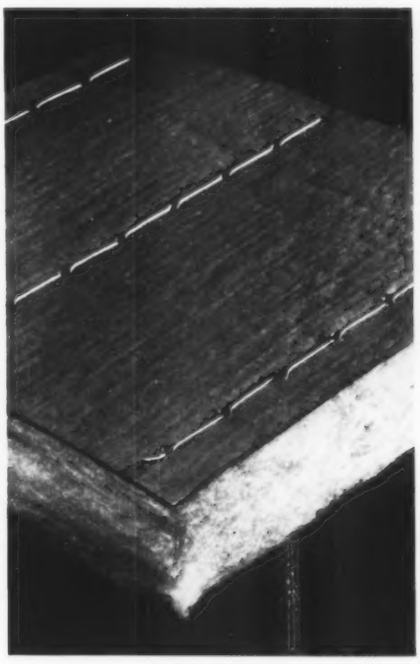
Spring end fits into recess molded in the plastic housing of this new 15 lb. capacity Chatillon pocket scale; thus load is transferred directly from spring to hook and plastic part serves only as housing for spring, graduated tube and tare tube. Translucent plastic housing is injection molded of Lumarith by the Northern Industrial Chemical Company for John Chatillon & Sons.



Net weight is obtained by adjusting polished brass white nickel tare tube to zero on the graduated tube of brass black nickel. Graduated tube is necked to accommodate spring anchor and hook.

Fibrous Glass and Cork, Six Inches Thick, Insulate New Ice Trucks

Insulated truck body—top, bottom and sides. These new ice delivery trucks built by Morris Soffe and Son, are designed to carry 900 lb. ice cubes and 3,000 lb. cake ice. Floors are insulated with one four-inch and one two-inch layer of Armstrong corkboard, with waterproof paper and plywood beneath metal interior lining. Framework is sealed with waterproof paper and plywood.

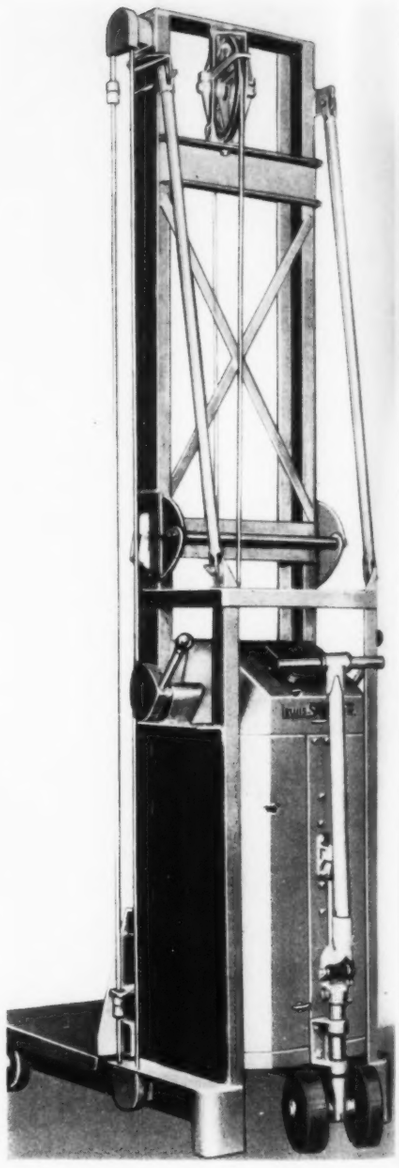


Two three-inch blankets of Fiberglas with Sisal-Kraft wire stitched to one side insulate the side walls. Tops are insulated with a six inch blanket of plain Fiberglas.

Modern Designs

Heatproof glass panel in the heavy-gage aluminum lid of the new Westinghouse Automeal roaster is easily removable for cleaning. Roaster also has removable inset pan of acid-resisting enamel. Handles are molded phenolic.

Conveyor, driven by a small, constant-speed motor, carries bread past heating coils, eliminating usual timing controls, signals or regulating mechanisms, in this new Crocker-Wheeler Toastolator. Chromium-plated top is removable.



Cable control in the new Lewis-Shepard stacker is through movement of ball-bearing mounted handle to exert a straight up-and-down pull on cable. Control is self-adjusting for hinged stackers; automatic extension or take-up is provided by anchoring the cable to a long spring which is recessed in the control handle.

RANDOM JOTTINGS ABOUT NEW DEVELOPMENTS

A new rolling mill, in Stockbridge, England, weighs 550 tons and is the largest of its kind in Europe. The mill is driven by a 500 hp. variable speed reversible electric motor, and will cold roll stainless steel sheets up to a width of approximately one meter. The backing rolls weigh 23 tons each, are 56 in. diameter rolls and are mounted on tapered roller bearings which weigh nearly four tons each. Each bearing has 48 in. outside diameter.

* * *

Weighing less than 33 lb., a new portable printer makes positive prints, up to 12 by 18 in. in size. Exposing, developing and drying of the prints is all done in five minutes.

COMING . . .

Design details of the new, air-conditioned, streamlined subway car having an axle loading weight one-half that of conventional cars —controlled by a single handle that operates motors, dynamic brakes, magnetic track brakes, and wheel brakes

CORK-RUBBER MATERIALS

For Mechanical Parts, Packings and Gaskets

R. M. HILL
Industrial Division, Armstrong Cork Company

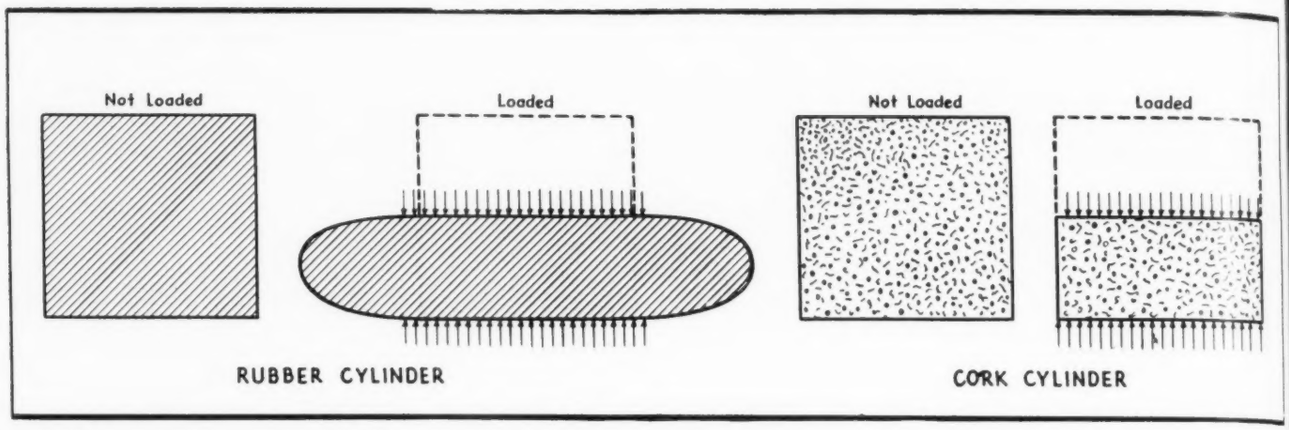
EACH of them, natural cork, cork-compositions, rubber and rubber-compositions, have characteristic properties peculiar to themselves which make them desirable materials for many mechanical and electrical products, as well as for parts in processing and transportation equipment. However, there are numerous applications where a material is needed that has properties which are intermediate between the properties possessed by cork and those possessed by rubber.

Rubber, processed from the sap of a tree, can be formed into almost any shape or size of piece that is wanted. Cork, on the other hand, the bark of a tree, in its natural state is a solid having a definite structure. Except in small sizes, however, cork is not available in pieces large enough, or perfect enough, to use for many industrial applications. To obtain materials that can be worked into sheets and shapes of large size it is necessary to granulate natural cork and then hold the granules with added glue, albumin or similar binders, thus producing a composition material.

Experiments, having as their objective the further development of the qualities of cork compositions by substituting rubber and synthetic rubber-like materials in place of the usual binders, have resulted in the development of cork-rubber compositions which can be formulated and compounded to obtain in various degrees as desired combinations of the characteristics of both rubber and cork. With the new binders made from rubber and synthetic rubber-like materials, cork-rubber compositions can be made in which the rubber content varies from 10 to 90 per cent of the total, thus securing a variety of compositions covering a wide range of physical properties. Throughout this article the word "rubber" refers to natural rubber and to the materials known as synthetic rubber.

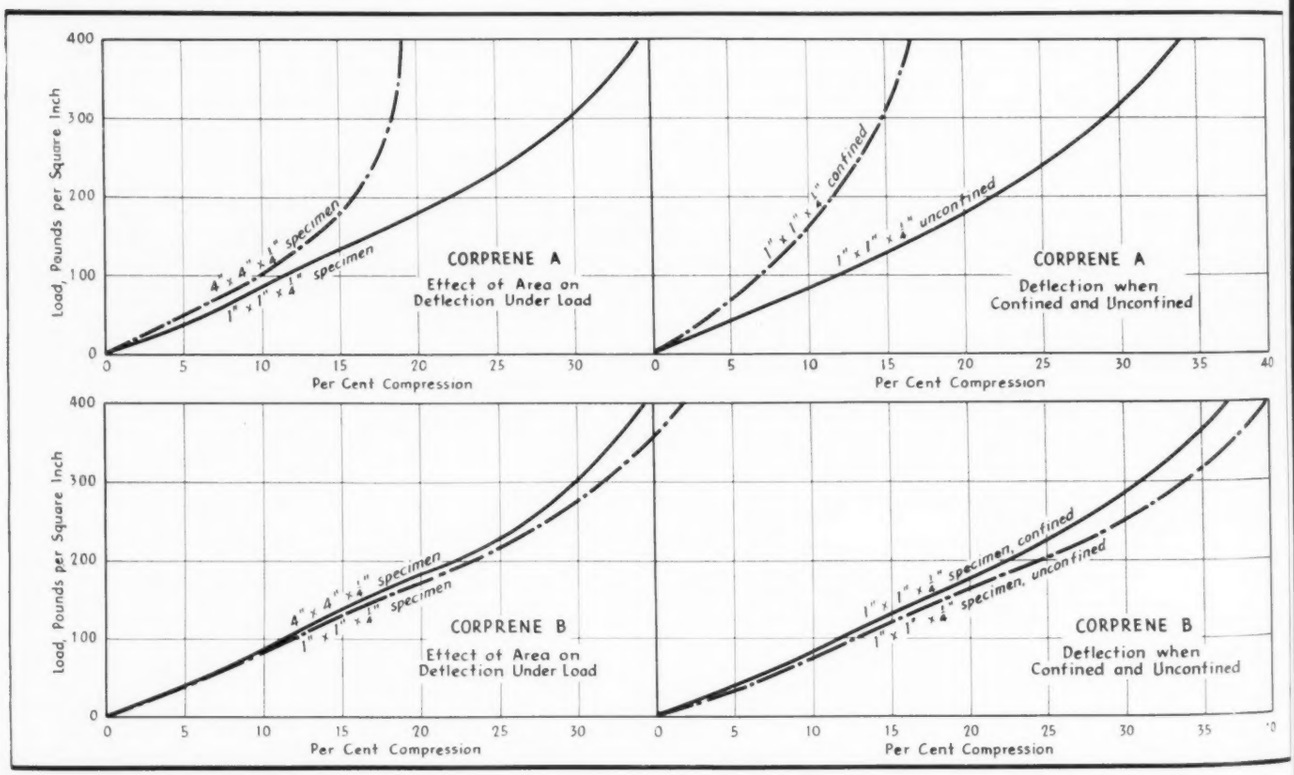
Several types of synthetic rubber-like materials are now available for use as binders. Each type has its own peculiar properties. One type is highly resistant to gasoline, others are resistant to certain oils, and some can be compounded to be resistant to water. Although one or two are restricted as to quantities available, and one or two are not good binders from the point of view of combining with the cork granules sufficiently so that they will cement or hold together, most of these binders can be used with cork in a wide variety of proportions to form a composition material.

Applications for cork-rubber compositions include water pump gaskets, gasoline dispensing valve disks, gasoline tank valve disks and gaskets, thermostatic valve packing, refrigerant valve gaskets, disks for vapor recovery vacuum relief valves, air valve seats, shaft oil seals, shock absorber seals, packings in grease guns, bushings for oil filled and cooled cables, oil-filled switch and transformer gaskets, vibration absorption units and feed rolls. (*Continued on next page*)



Load deflection properties of rubber are almost the opposite of those possessed by cork. Rubber, like water, is practically non-compressible; under load rubber deflects or flows in all unconfined directions. A short cylinder of rubber with a cross section of 1 sq.in. when squeezed to one half the free height undergoes no change of volume, there is merely a change of shape with the material flowing or bulging out on all sides, the average of the cross-sectional area becoming 2 sq.in., the volume remaining constant.

Cork is compressible. A short cylinder of cork with a cross section of 1 sq.in. when squeezed to one half the free height decreases practically 50 per cent in volume with hardly any change in the shape or area of cross section. The structure of cork being cellular, the air in the cells is compressed when a compressive load is applied. While the load is being released the captive air in the cork expands to normal pressure thus restoring the cork cylinder to its former unloaded shape and size.


Load, Pounds per Square Inch
400
300
200
100
0
4" x 4" x 1" specimen
1" x 1" x 1" specimen
CORPRENE A
Effect of Area on Deflection Under Load
0 5 10 15 20 25 30
Per Cent Compression
1" x 1" x 1" confined
1" x 1" x 1/4" unconfined
CORPRENE A
Deflection when Confined and Unconfined
0 5 10 15 20 25 30 35 40
Per Cent Compression
Load, Pounds per Square Inch
400
300
200
100
0
4" x 4" x 1" specimen
1" x 1" x 1/4" specimen
CORPRENE B
Effect of Area on Deflection Under Load
0 5 10 15 20 25 30
Per Cent Compression
1" x 1" x 1" specimen, confined
1" x 1" x 1/4" specimen, unconfined
CORPRENE B
Deflection when Confined and Uncontined
0 5 10 15 20 25 30 35
Per Cent Compression

Cork-rubber compositions, obtained by processing rubber and cork mixtures, when placed under compression behave in a manner which is determined by the proportions of rubber and cork in the mixture, by the size of the cork particles and by the type of rubber of synthetic material used.

When a composition processed from a mixture of rubber and cork particles is squeezed, the incompressible rubber flows and compresses the cork particles. Under low pressures this flow takes place almost entirely within the composition. As the axial compression continues the internal flow of the rubber or rubber-like binder becomes greater than the cork particles can accommodate and some side flow takes place.

The degree of compressibility and side flow that is desired can be controlled within close limits by selection of the particle size and volume of cork in the mixture. The graphs shown here illustrate the properties obtained with two different formulas. Corprene *A* is only slightly compressible in volume, with properties approaching those of rubber. Corprene *B* is highly compressible in volume and has little lateral flow with properties approaching those of cork. With Corprene *B*, the area of the material has little effect on the deflection under load, also the rates of compression when confined and when unconfined are about equal. By selecting the proper particle size and proportion of cork used the ultimate compressibility and lateral flow can be predetermined.

Mechanical parts made of cork-rubber compositions. The six-armed block which is used between the jaws of a flexible coupling, is molded from a mixture which is formulated to have the correct degree of compressibility for the torque transmitted. The flow characteristics of the material are such that the spider will not distort axially and thereby set up an end thrust.

Handle and lever grips made of cork-rubber compositions are resilient and shock absorbing. Cork-rubber mixtures are being used for damping elements in vibration absorption units and can be loaded in compression, shear or tension. Center bearing pads and pedestal liners with rubber-cork composition elements are used on some railroad car trucks.

Feed rolls and guide rolls made of cork-rubber compositions are used for packaging and duplicating machinery. The high coefficient of friction, non-sticking and low static generating properties of Corprene are desirable in such applications. While certain Corprene mixtures used for packings have low coefficients of friction others have coefficients as high as one and a half times that of natural cork.

Disks for many types of valves are made of cork-rubber compositions which are formulated to secure many different properties. Valve disks for carbon dioxide service must be impervious to penetration by gas at pressures as high as 2,000 lb. per sq.in., and must be dense and non-flowing but sufficiently compressible to permit slight mechanical penetration.

Molded packings, gasket materials, sheet and strip materials are made using several types of rubber or synthetic rubber-like materials with cork in a variety of proportions, each finished product having its own individual properties. Some are compounded to resist gasoline, others to be resistant to specific oils and greases, still others to be resistant to water. In compounding a material for a definite purpose, the particular natural or synthetic rubber selected is one that will produce the solvent or oil resistant properties desired and mixed with the correct amount and type of cork to produce the physical properties required to suit the expected service or application.

The addition of cork to rubber or synthetic rubber compounds greatly reduces the tendency to stick or freeze to metals with which they are in contact under pressure. This characteristic is caused by the fact that the area of rubber exposed to the metal surface is reduced by the presence of cork. In molded pieces even when the entire surface is rubber with no cork particles exposed the tendency to stick to metals is reduced.

Another property of the cork and rubber mixtures used for sealing liquids and gases is that they are continuous in structure because of the rubber binder present. Because of this property gaskets do not need to be subjected to flange pressure to be impervious to the flow of the liquids or gases which they confine. The frictional properties of cork-rubber mixtures, along with controlled compressibility and controlled cold flow, are important considerations in gasket materials for many applications such as gaskets for side plates on diesel engines, circuit breaker and transformer gaskets, and sight glass gaskets for oil pumps. No cement is required when installing gaskets of rubber-cork materials.

Gaskets can be furnished made of materials compounded with synthetic materials which will swell when in contact with oil and thus increase the tightness of the flange.

Gasket materials which do not tarnish silver or brass, can also be compounded. Adhesive coatings can be applied to cork-rubber compositions to facilitate assembly. This property is made use of in materials for floor treads, friction strips on interior walls of railway coaches to prevent panels from squeaking, non-slip disks, and gaskets.

CENTRIFUGAL CLUTCHES

Formulas for Calculating Torque and Power

D. N. DRUGIS

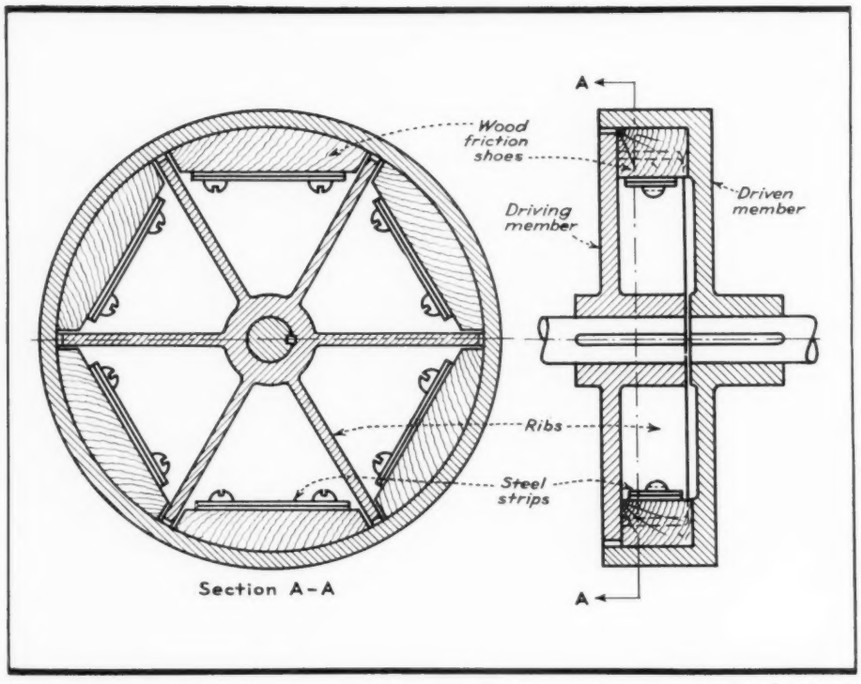


Fig. 1—Simple design of centrifugal clutch in which a single ring of friction shoes is carried in pockets of the driving member

DESIGN PROBLEMS involving the starting of machines under heavy loads can often be solved by selecting a centrifugal clutch to act as a time delay element between the motor and the driven machine. Applications of this principle are found in many types of machine drives for centrifugal separators, woodworking machinery, and textile machinery.

Centrifugal clutches are particularly advantageous when motors with a low starting torque happen to be the chosen motive power. A properly proportioned clutch is an automatic starter which allows the motor to attain a predetermined speed before picking up the load and that gradually increases the speed of the driven member without shock to transmission or motor.

One of the simpler centrifugal clutch designs which has given satisfactory results, shown in Fig. 1, consists of a cup-shaped driven member having an internal friction face, which engages centrifugal friction shoes that are carried loosely in pockets in the driving member of the clutch. This type of clutch can be placed directly between the motor and driven member to serve as an automatic starter, clutch and flexible coupling.

Another design of centrifugal clutch in which two sets of friction shoes and two friction faces are used is shown in Fig. 2. The outer set of shoes A is carried in the driving member and as soon as the motor starts up these shoes are pressed by centrifugal force against friction face B. The inner set of shoes C is carried in the driven member of the clutch, these shoes are forced against friction face D as soon as the driven member begins to revolve, and the frictional hold between the members gradually increases until full speed is attained.

The horsepower capacity of a centrifugal clutch depends on the same general factors which determine the capacity of other types of friction clutches, except that the pressure between the friction faces is produced by the centrifugal force of the friction shoes instead of by springs or other means.

The various factors involved when calculating the horsepower capacity of centrifugal clutches are

Hp = horsepower
N = r.p.m. of driver
D = diam. of friction face in in.
V = velocity in ft. per min. at friction face
F = tangential force in lb. at friction face
P = pressure between friction surfaces in lb.
f = coefficient of friction

The horsepower of a frictional drive can be calculated from

$$Hp = \frac{F\,V}{33{,}000}$$

in which $V = \frac{\pi\,D\,N}{12}$, then by substituting

$$Hp = \frac{\pi\,F\,D\,N}{33{,}000 \times 12}$$

$$= 10^{-6} \times 8D\,N\,F \qquad (1)$$

The driving power of the clutch depends on the pressure holding the two friction surfaces together and the coefficient of friction between the two surfaces. This pressure can be determined from

$$P = F/f, \text{ or } F = Pf$$

then by substitution Equation (1) becomes

$$Hp = 10^{-6} \times 8\,f\,DNP \qquad (2)$$

from which

$$P = \frac{Hp}{10^{-6} \times 8\,f\,D\,N} \qquad (3)$$

In centrifugal clutches the pressure P is created by the centrifugal force of the driving shoes. It is, therefore, important that the weight of the shoes be accurately calculated when determining the pressure which they will exert at starting and at running speeds.

Let C = centrifugal force
W = weight of friction shoes in lb.
N = r.p.m.
R = radius to center of gravity of friction shoes in ft.

Then the equation for centrifugal force is

$$C = 10^{-5} \times 34\,WRN^2$$

It is evident that the factors for cen-

trifugal force C can be substituted for P in Equation (2), which will then be expressed as

$$Hp = 10^{-11} \times 272 \times f\ D\ N^3\ W\ R \quad (4)$$

It is usually more convenient to have R expressed in inches instead of in feet. Designating the radius to center of gravity of friction shoes in inches by r Equation (4) becomes

$$Hp = 10^{-12} \times 227 \times f\ D\ N^3\ W\ r \quad (5)$$

from which

$$W = \frac{10^{12} \times Hp}{227 \times f\ D\ N^3\ r} \quad (6)$$

It is possible to further simplify the calculations by reducing the factors $227 \times N^3$ to a series of constants computed for values of N. If for any value of N constant K equals

$$10^{-12} \times 227 \times N^3$$

the horsepower Equation (5) becomes

$$Hp = K\ D\ W\ f\ r \quad (7)$$

and Equation (6) becomes

$$W = \frac{Hp}{K\ D\ f\ r} \quad (8)$$

Constants for K at various speeds are presented in Table I for ready reference. From the equations which have been developed it is evident that:

1. The centrifugal force of the shoes and therefore the torque developed by a centrifugal clutch varies directly as the square of the speed.

2. Horsepower developed by a centrifugal clutch varies directly as the cube of the speed.

3. Horsepower developed by a centrifugal clutch varies directly as the coefficient of friction and the weight of friction shoes.

An electric motor starting a heavy load through a centrifugal clutch has a characteristic power curve like that shown in Fig. 3. In Fig. 4 is shown a relative speed curve of the motor and driven member, indicating a gradual increase of speed of the driven member with no shock to motor or transmission.

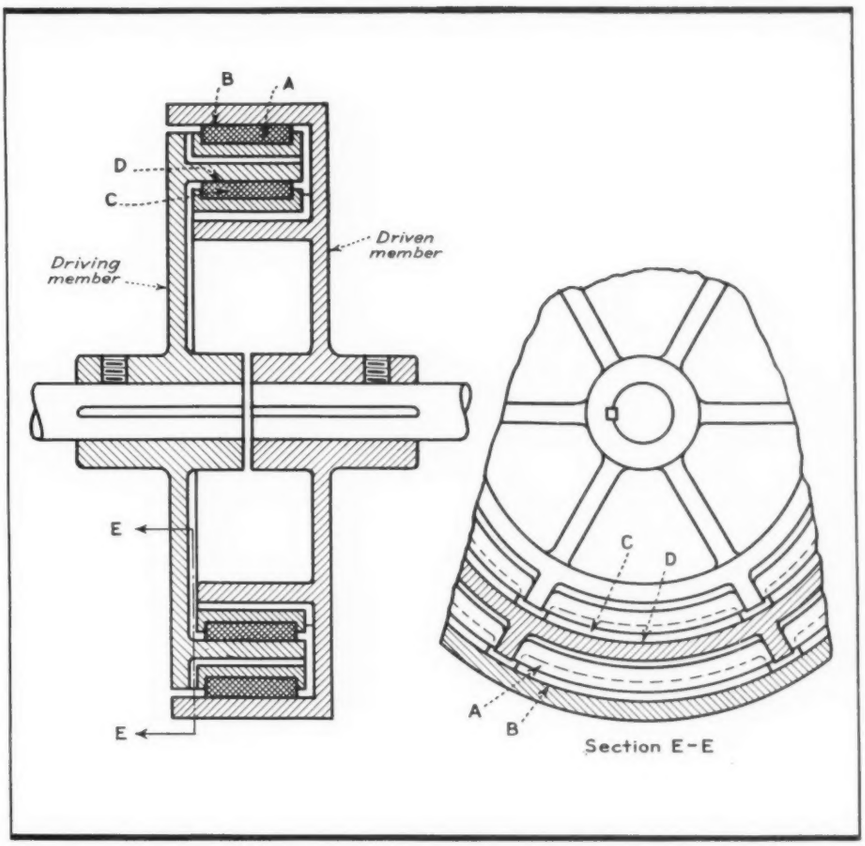


Fig. 2—Two sets of friction shoes and two friction faces are used in this design of centrifugal clutch. The outer set of shoes takes hold when the motor starts and the inner set of shoes grips as the driven member picks up speed

Table I—Constants K for Values of N

N	K	N	K	N	K
100	0.000227	870	0.149480	1,500	0.766126
200	0.001816	900	0.165482	1,600	0.929792
300	0.006150	1,000	0.227000	1,700	1.115252
400	0.014528	1,100	0.302140	1,740	1.195842
500	0.028376	1,160	0.354324	1,800	1.323864
600	0.049032	1,200	0.392240	1,900	1.556994
700	0.077860	1,300	0.498718	2,000	1.816000
800	0.116224	1,400	0.622688		

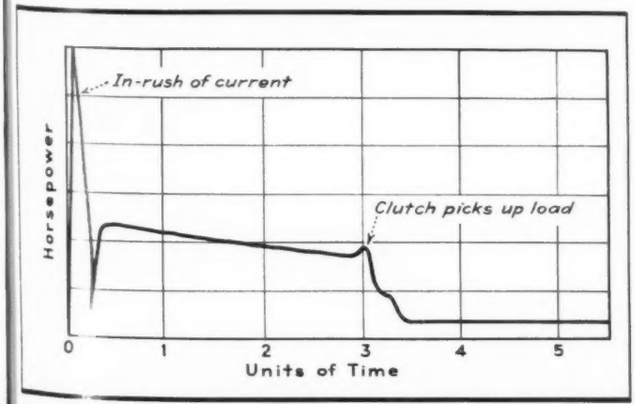


Fig. 3—Characteristic horsepower curve of an induction motor and a centrifugal clutch starting a heavily loaded machine

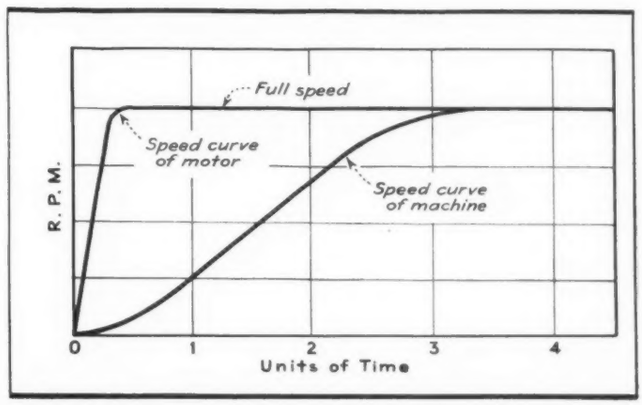


Fig. 4—Characteristic curve showing relative speed of motor and driven machine as centrifugal clutch engages

SUPERFINISH

A New Method of Machining Surfaces

A. M. SWIGERT
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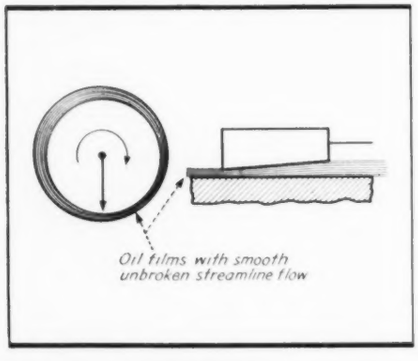
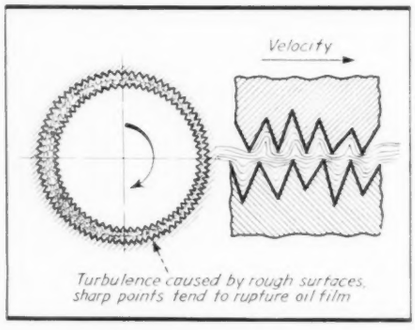
A TREMENDOUS amount of interest has been shown throughout industry in the Superfinishing program. This program has, of course, been concerned with machined surface finishing. Notwithstanding the great amount of work done on the surface finishing problem during the past, there is at present no practical way of specifying surface finish. Numerical values that can be used for comparison cannot be obtained by sliding the finger nail or other thin edge across the surface, or by visual inspection with the naked eye. Surface reflectivity is not an index of surface smoothness because reflection is determined by a number of factors other than smoothness. The profilograph, which draws a graph of the magnified vertical movements of a needle drawn across the surface, is essentially a laboratory instrument. Thus, the only practical way of specifying finish is to indicate on the drawings the process by which the surface is to be produced, such as machining, grinding, honing, burnishing, broaching, lapping, polishing or other method. Admittedly, a great variation in degree of surface finish will be obtained with any one of these methods, but it seems that, for the present at least, this is the only practical method of specifying surface finish.

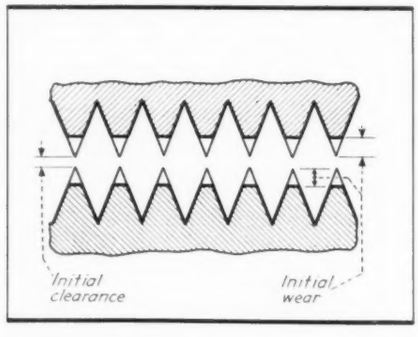
No attempt has been made in this article to cover each finishing method completely; the main purpose is to compare relative surface smoothness, load carrying properties and general characteristics.



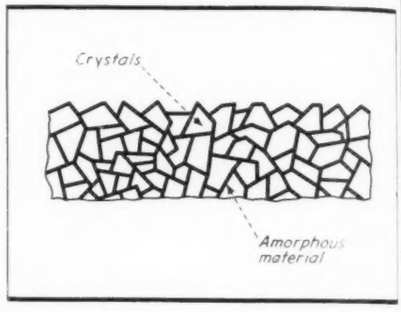
Theory of lubrication assumes perfectly smooth surfaces that will permit streamline flow of lubricant, that is, the absence of turbulence, thus permitting undisturbed shearing of the layers of molecules in the oil film supporting the load. Smooth bearing surfaces are therefore necessary in order that the oil film may be established as quickly as possible and may present an unbroken surface for supporting the load. Under such condition duration of metal-to-metal contact at starting and the bearing friction during running will be a minimum.



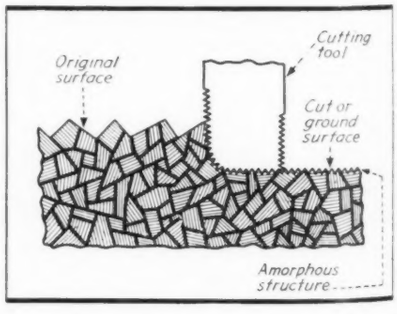
Surface roughness, consisting of peaks and valleys, causes turbulent flow, breaks the continuity of the oil film and thereby decreases the load carrying capacity of the bearing. Metal-to-metal contact is likely to occur during running, while the metal-to-metal contact at starting will persist for a longer time. Bearing friction will be correspondingly higher.



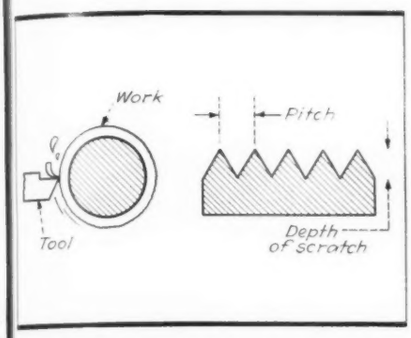
Rough bearing surfaces wear rapidly because of metal-to-metal contact. Though the volume of metal removed from the sharp peaks is small, the initial wear as measured by increased bearing clearance is relatively large. This is further aggravated by the worn-off particles of metal getting into the lubricant. Result may be noisy operation and excessive friction with accompanying overheating and chance for abrading and scoring.



Metallurgical considerations. "Crystals . . . are the little bricks of which all metals and alloys are made up . . . Between adjacent grains the narrow spaces are filled with amorphous metal or cement . . . Beilby contends that during the polishing of metals with very fine powders thin layers of amorphous metals are produced considerably harder than the metal itself and necessarily severely strained."—*The Metallography and Heat Treatment of Iron and Steel* by ALBERT SAUVEUR, who is considered by many to have been the most outstanding metallurgist of all time.

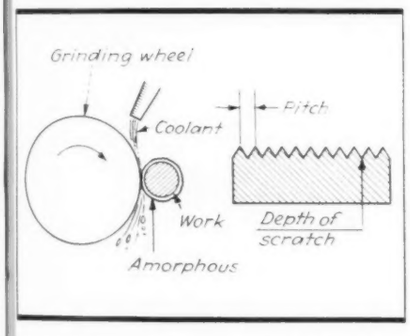


In the cutting or grinding of metals there is produced by pressure and heat a surface layer of amorphous or non-crystalline structure of the piece being machined. This considerably harder thin amorphous surface layer over the softer crystalline structure tends to crack and scale off when subjected to high concentrated pressures or impact and therefore it should, if possible, be removed to expose the hard crystalline structure to take the load and resist wear.



Steel cutting tools used in turning, boring, reaming, etc., relatively produce the roughest surface, the scratch pitch or distance between peaks being the greatest. Cutting speed is relatively high, from 20 to 600 ft. per min. in turning, and cutting pressure is extremely high.

Lapped tungsten carbide cutting tools produce a surface that is smoother than that produced by tool steel, the scratch depth and scratch pitch being considerably less.

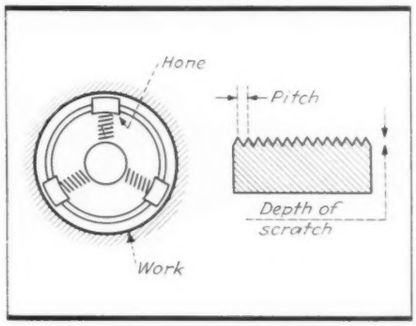


Grinding, also performed at high speed, 1,000 to 8,000 ft. per min. and under considerable pressure, generally gives a smoother surface. It may be considered that each individual grit is a single point cutting tool.

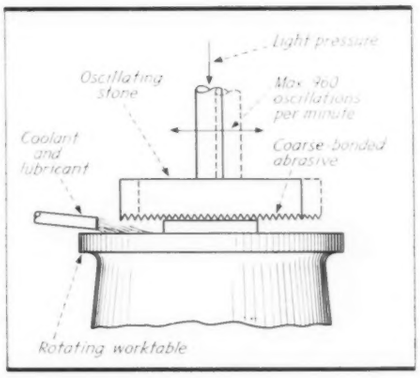
Because speed, pressure and accompanying heat are unavoidable when cutting with tool steel or tungsten carbide or when grinding in the conventional manner, the formation of a surface layer of amorphous material is unavoidable when finishing a surface by any of these methods.

Honing produces the finish by virtue of surface contact between the finishing tool and the surface being finished, as contrasted to point contact in metal cutting and line contact in grinding. Pressure, speed and heat generated are much less than in cutting, or grinding and amount of amorphous material on the surface produced is probably negligible. Although essentially a surface finishing process, a limited amount of metal is removed and in cylinder finishing the process is used for producing both finish and dimension. The stones oscillate and reciprocate simultaneously, this accounting for the smoother surface produced.

Lapping, wherein an abrasive compound is rubbed between the surface to be finished and that of a lapping stone, produces the smoothest surface. However, this process cannot be classed as a commercial finishing method for quantity production as generally it is a slow



hand operation. So-called machine lapping develops the finish primarily by creating a surface by the smearing of the exposed amorphous layer. This flows the material at the peaks of the scratches into the valleys, thereby producing a smooth appearing finish.



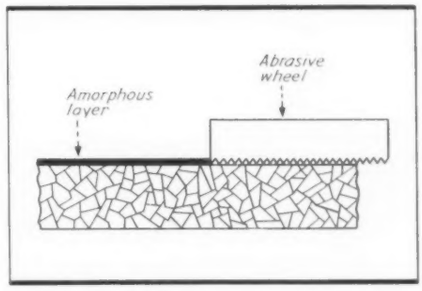
Superfinishing requires at least three motions, rotation of the stone, oscillation of the stone and rotation of the work. More motions such as intermittent lifting of the stone, are sometimes added, also change of work speed, change of pressure and change of stone oscillation speed.

Surface velocity between work and wheel are low, of the order of 10 ft. per min. Pressure of stone against work is low, ranging from a few ounces to a few pounds per sq. in. of stone area. Coolant serves not only to cool but also to lubricate in order to wash away chips and prevent scratching. Stone has a coarse grit.

Thus, pressure, speed and heat are negligible and the coarse grain of the abrasive wheel scrubs off the amorphous layer produced by the previous machining operation.

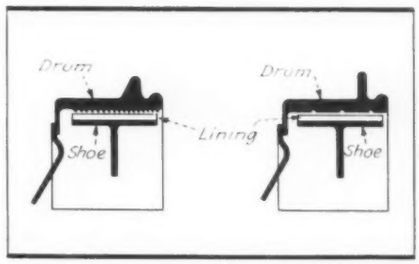
The amorphous layer is removed and the crystalline metal surface is exposed, presenting the maximum area for wear resistance and load-carrying bearing surface that can be produced.

Ordinarily the amount of material removed is negligible, dimensional changes being of the order of 0.0001 in. If de-



sired, however, the process can be modified to produce a stock removal of 0.001 in. or more.

However, though it is impossible or impractical to measure surface finish, the qualities, properties and characteristics of surface finishes are recognized. Numerical data that show the relation of smoothness of surface finish to wear resistance, sliding friction, heat transfer and similar factors, is becoming more and more available as more concerns attack the surface finish problem. However, the qualitative relationships of the various finishing methods are well established and readily explainable.



Rough surfaces for braking will wear rapidly because of the peaks of the scratches wearing down. The worn off material imbeds itself into the softer brake lining, eventually causing squeaky brakes and diminishing the brake friction. Superfinish will give the maximum braking surface, smoother action and longer effectiveness and life. This also applies to clutch plates and clutch disks.

In some applications such as the fit of steel-backed bearings in their housings, intimate surface contact is desired in order to obtain maximum rate of heat conduction. Rough surfaces wherein only a fraction of the total areas are in direct contact act as a partial heat insulator, thereby greatly lowering the rate of heat transfer. Rapid heat dissipation lowers the bearing temperature.

NOTE—Details of the Superfinishing method can be found in the July 27 and Aug. 10, 1938 numbers of *American Machinist*.

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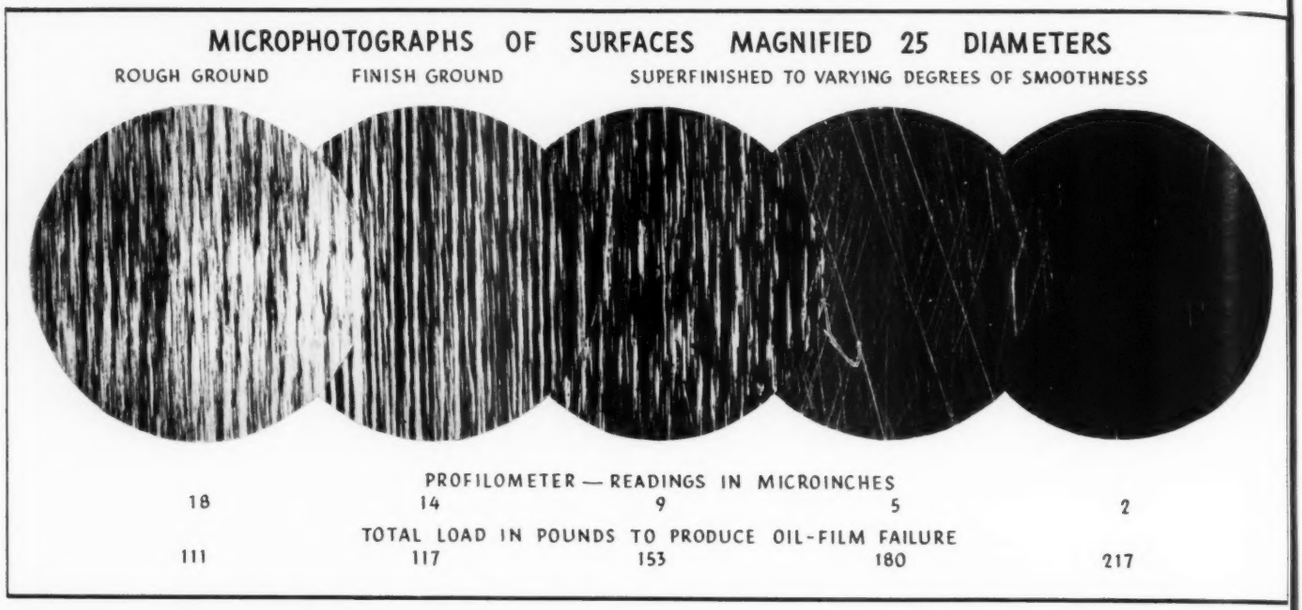
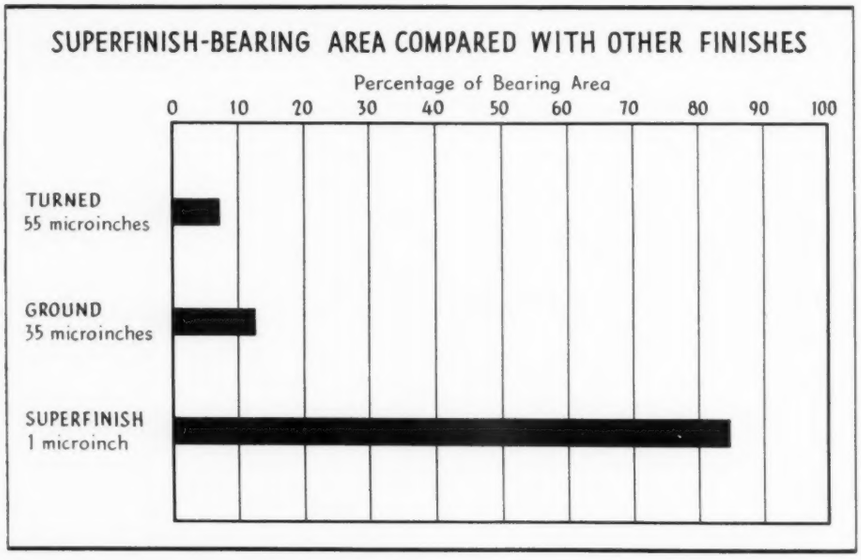
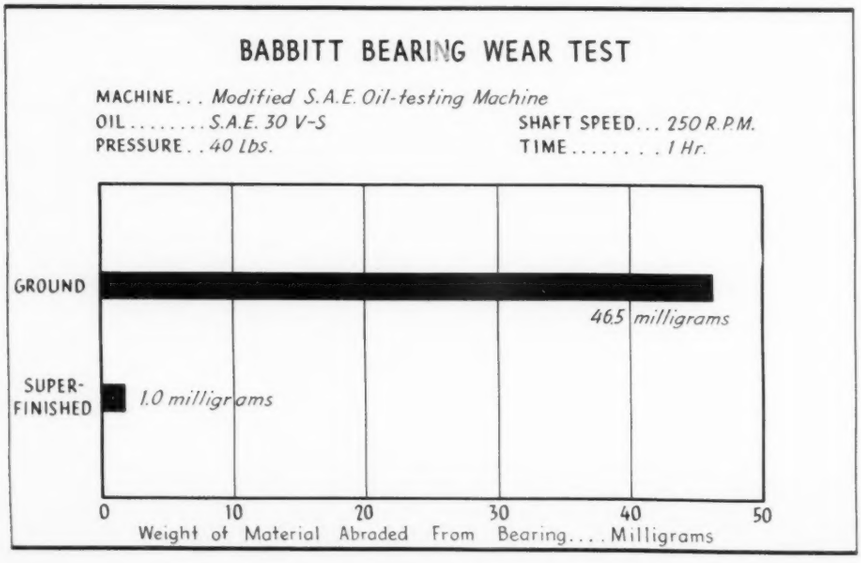
SUPERFINISH—*A New Method of Machining Surfaces* *Continued*







Materials That Can Be Superfinished

CAST IRON, STEEL
Of Any Analysis or Hardness

ALUMINUM
Cast or Rolled

COPPER
Plated or Solid

CHROMIUM-PLATED PLUGS

GLASS

WOOD

TIN

FIBER

MOLDED BRAKE LININGS

Shapes That Can Be Superfinished

Flat, cylindrical, concave or convex surfaces can be Superfinished.

Time Required for Superfinishing

Time on a job, such as a piston pin one at a time, is not more than 20 sec. In actual production, parts are Superfinished at the rate of several hundred per hour.

WHAT IS INVENTION

H. A. TOULMIN, JR.
Toulmin & Toulmin

PART II in the series of articles which enumerate the positive rather than the negative aspects of new and useful ideas that may be patentable, and that also consider the qualities which make an invention patentable.

Use of an old structure for analogous purposes in another industry constitutes patentable invention: (*a*) if the new use accomplishes a new and useful result in the industry to which the old structure is adapted: (*b*) if the two industries are sufficiently unrelated that a person ordinarily skilled in one would not be expected as a matter of course to know of the methods used in the other; (*c*) if it took creative imagination to see the applicability of the old structure to a new use. Usually such an adaptation fills these three requirements.

An old combination of parts, or an old part, producing a new result is invention, *provided a new result is produced*. Thus a shock absorber mechanism for automobiles consisted, in this order, of an axle, a leaf spring and a coil spring. It was old in the art. An inventor merely reversed the order of the springs, that is, he put the coil spring between the axle and the leaf spring. Applied to the Ford car, it gave new riding qualities. The court held this to be invention. This is also true if the new result is achieved by combining old and new parts.

Reorientation of a series of old parts in a new association, even though the result is old, can be invention. Chemical elements, mechanical and electrical parts, mechanical movements, electrical connections and circuits, and the like, are all part of our common stock of knowledge. Numberless combinations of these elements can be arranged to give new results or to give old results in a better way.

In one case the Supreme Court of the United States said: "The first defense is based on the theory that a patent cannot be valid unless it is new in all its elements as well as in the combination, if it is for a combination. But this theory cannot be maintained. . . . So a new combination of known devices whereby the effectiveness of a machine is increased may be the subject of a patent."

Increased production speed. While ordinary increases in production speed such as could be expected from the exercise of ordinary mechanical skill or engineering knowledge is classified as change in degree and is therefore unpatentable, any such improvement which is revolutionary in character or unusually great in amount—beyond what would be expected from the ordinary slow evolution of the art—is held to be patentable. The two classical instances of this are the patent which increased the production of looms from 40 to 50 yards of cloth a day, and the Eibel patent on paper making machines which increased production 20 per cent.

Transposition of parts. Merely to change parts from one position to another is patentable invention, if: (*a*) it results in the solution of a formerly unsolvable problem; (*b*) if the results are different from or unexpectedly greater than from the old position; (*c*) if the transposition brings about a new co-action between the parts.

Addition of parts with change of function. According to the customary tests applied by the courts to determine whether an invention is patentable, the addition of a part to a machine is invention if it results in a new combination or an old combination producing a new or improved result in an easier, cheaper or better way. In one case the court said: ". . . the combination . . . possesses patentable novelty because to the enumerated old elements is added 'a trap connection with said bulb'."

In a case concerned with an improvement on a fan the court held: ". . . Furthermore, if the introduction of this adjustable crank disk, considered as one element, into the combination of an oscillating electric fan, itself a recognized combination, produced through the co-action of all the elements, an entirely new and useful result or an old result in a new, more facile, economical and efficient way, it constituted invention."

Omission of parts. If a part formerly used is left out of a device, there is patentable invention provided that an improved or unexpected result occurs. That is also true where the machine retains the function of the omitted part.

As an example of the first condition consider this court decision: "The machinery and apparatus used by Lawther had all been used before. His only discovery was an improvement in the process. He found that, by altogether omitting one of the steps of the former process—the grinding and mixing under the mullerstones—and mixing in the mixing-machine by means of steam, a great improvement was effected in the result.

"Why should it be doubted that such a discovery is patentable? It is highly useful, and it is shown by the evidence to have been the result of careful and long-continued experiments and the application of much ingenuity. . . . We cannot but think that Lawther discovered a new process of manufacturing oil from seeds, and that he was entitled to a patent therefore."

Use of an old thing for new and non-analogous purposes. The inventive imagination which is an essential of true patentable invention is often demonstrated by transplanting an old device into an entirely new field which is not related to the old field, and, of course, to secure a new and useful result. Under these circumstances the new environment must be such that the device does not function in the old way. The Supreme Court of the United States has handed down the following decisions on this point.

In one it said: ". . . La Rue was the first to apply the principle of the torsional spring to telegraphic instruments, although springs of similar description had been previously used in clocks, doors, and perhaps some other articles of domestic furniture. . . . We think the adaption of this somewhat unfamiliar spring to this new use, and its consequent simplification of mechanism, justly entitles the patentee to the rights of an inventor."

And finally: "It appears from the testimony that several of these addressing machines, of which that of Dennis and York is a type, and which are now claimed to have inspired the Beach patent, had been upon the market for many years, and yet it never seems to have occurred to anyone engaged in the manufacture of paper boxes that they could be made available for the purpose of attaching strips to the corners of such boxes. This very fact is evidence that the man who discovered the possibility of their adaption to this new use was gifted with the prescience of an inventor. While none of the elements of the Beach patent —taken separately or perhaps even in a somewhat similar combination—was new, their adaption to this new use and the minor changes required for that purpose resulted in the establishment of practically a new industry, and was a decided

step in advance of any that had theretofore been made.

". . . We agree . . . that it did involve invention to see that a machine of the Dennis and York type was adaptable to the work of the Beach device, and, second, to make such changes as were necessary to adapt that device to its new function. With all the anticipating devices before us, it is apparent that the mere change in the shape of the dies was a minor part of the work involved in so changing the Dennis and York machine as to make it perform a wholly different function, the invention consisting rather in the idea that such change could be made, than in making the necessary mechanical alterations."

Substitution of materials. I have discussed this important subject in considerable detail in an article "Substitution of Materials" which appeared in the September, 1937 issue of *Product Engineering*. The rule can be summed up as follows: "Where the substitution of one material for another in a combination results in a new and unexpected result not customarily associated with the use of the particular materials so substituted, there is invention."

Integral or separate. To make a thing in one piece instead of several is invention if the new article has advantages as a result of the integration, over the original thing.

One of the most striking cases of this was that of the Krementz one piece collar-button. Here the Supreme Court of the United States said in part: . . . The learned judge (of a lower court) was, however, of the opinion that 'any competent mechanic, versed in the manufacture of hollow sheet-metal articles, having before him the patents of Stokes and Keats, could have made these improvements and modifications, without exercising invention, and by applying the ordinary skill of the calling'.

"In the present instance, however, we find a new and useful article, with obvious advantages over previous structures of the kind. A button formed from a single sheet of metal, free from sutures, of a convenient shape, and uniting strength with lightness, would seem to come fairly within the meaning of the patent laws. . . . Buttons made of several pieces are liable to break at the soldered joints, and it is stated by an experienced witness that the metal, by the process of soldering, becomes soft and liable to bend. The different pieces are set together by hand, and are not always uniform or put together truly.

"The view of the court below, that Krementz's step in the art was one obvious to any skilled mechanic, is negatived by the conduct of Cottle, the president of the defendant company. He was himself a patentee under letters granted April 16, 1878,, for an improvement in the construction of collar and sleeve buttons, and put in evidence in this case. In his specification he speaks of the disadvantages of what he calls 'the common practice to make the head, back and post of collar and sleeve buttons separate, and to unite them by solder. His improvement was to form a button of two pieces, the post and base forming one piece, and then soldering to the post the head of the button as the other piece. Yet, skilled as he was, and with his attention specially turned to the subject, he failed to see, what Krementz afterwards saw, that a button might be made of one continuous sheet of metal, wholly dispensing with solder, of an improved shape, of increased strength, and requiring less material."

Mechanical skill. While an "invention" which shows only the exercise of mere mechanical skill is not patentable, mechanical skill is often the foundation for patentable invention. Invention may flow from the ability to see how the common knowledge of an art may be employed to advance the art. That involves, usually, a great knowledge of the mechanical principles used in the art and capacity to understand their possibilities. Usually mechanical skill plus scientific knowledge is involved, but the fact that mere mechanical skill is exercised in the physical embodiment of an invention does not disprove invention. It is to be remembered that the borderline between mechanical skill and true invention is sometimes as difficult to determine as that between other mental processes.

This question of the part of mechanical skill in invention is so important and at the same time so difficult to appraise that it seems worthwhile to clarify it by quoting some court decisions.

In one case the court said: "It is no argument against invention that the inventor availed himself of all knowledge known to mechanics skilled in the art, nor is it surprising that, when a definite result has been accomplished, the simplicity of the methods by which it is accomplished would seem to be obvious. The line between the skilled mechanic and the ingenuity of the inventor cannot be accurately drawn in any given case, but where a demand has long existed, and men skilled in the art have sought to meet that demand without success, the argument that the methods employed by the inventor who has solved the problem are so obvious as to involve only mechanical skill, is not entitled to very serious consideration."

The point is brought out in considerable detail in the following decision: "Where, as in this case, the departure from former means is only small, yet the change is important, the doubt as to whether the inventive faculty has been exercised is to be weighed in view of the fact that the device in question has displaced others which had previously been employed for analogous uses, and this may decide the issue in favor of invention.

"It is a fact entitled to serious consideration in determining whether Anderson's improvement was so obvious as to be one which would occur to a mechanic skilled in the art that Van Depeole, with his conceded skill, did not attain the desired end. His mechanisms were faulty in exposing the brush to injury and retarding the wheel in operation by friction. Anderson's device does away with the objectionable features of Van Depeole in so satisfactory a manner that it was at once adopted, and has remained in general use. His change seems simple enough now, but it was the first to combine comprehension of the problem to be solved with a practical arrangement of parts for its solution. This entitles his advance to the merit of invention. The result is new in furnishing a brush of practical utility protected in operation. Its usefulness is demonstrated in its widespread adoption and use. We therefore reach the conclusion that Anderson's improvement rises to the dignity of invention, entitled to the protection of the patent law."

Crowded art. In many arts there have been constant and long-continued efforts by many inventors to achieve certain much-wanted results. When these have all been unsuccessful until some genius either discovered a solution along new lines, or combined the unsuccessful attempts of others to effect a successful one, there is usually invention. The court assumes that where many people have overlooked the solution, the one who sees the missing link, no matter how simple, has exercised the creative faculty and has not merely done something obvious. The contrast between the long search for a solution and the final successful step usually demonstrates that there has been invention.

There have been numerous decisions along this line, one of the notable ones saying, in part: "In an over-crowded art, where a broad generic invention is not possible, a defendant who omits altogether one element of a combination cannot be held as an infringer, even though he makes another element do double the work."

In the case of the Eibel patent on paper machines, the court said: "The fact that in a decade of an eager quest for higher speeds this important chain of circumstances had escaped observation, the fact that no one had applied a remedy for the consequent trouble until Eibel, and the final fact that when he made known his discovery all adopted his remedy, leave no doubt in our minds that what he saw and did was not obvious and did involve discovery and invention."

ELECTRICAL CONTACTS—II

Factors Affecting Their Life and Performance

K. L. EMMERT, J. W. WIGGS, and V. E. HEIL
P. R. Mallory & Company, Inc.

TUNGSTEN CONTACTS are often employed in low voltage d.c. circuits which contain an appreciable amount of inductance, such as ignition circuits, vibrator circuits, voltage regulator circuits, and low voltage fuel pump circuits. Tungsten is desirable for this type of operation because of its hardness, its ability to operate at high current densities without having the contacts stick because of fusion of the contact material, and also the transfer of material from point to point is less than with most of the other contact materials.

To study the effect of various condenser capacities across tungsten contact points and the resulting phenomena which govern performance of the points, a circuit shown in Fig. 6 was employed. A 6-8 volt d.c. generator with a battery connected across its terminals was used as a source of potential and was operated at 7.1 volts. The primary winding of the induction coil, which had an inductance of 6.2 millihenries and a resistance of 1.4 ohms, was connected in series with the pair of contact points which were shunted with condensers varying from 0.474 mfd. to 0.052 mfd. A rotating cam with 6 lobes was used to make and break the contacts. A cathode-ray oscillograph was connected across the contacts for observing the primary peak voltage, the frequency of primary oscillation, and shape of the first ½ cycle of the wave at various cam speeds.

A. Voltage Characteristics Across the Contact Points

When the contact points are separated the coil and condenser form an oscillating circuit and produce an oscillatory voltage across the contact points, as shown in Fig. 7. The oscillographic observations, summarized in the curves of Fig. 8, show that the peak voltage decreased with an increase in cam speed and with an increase in condenser capacity. The decrease in peak voltage at the higher cam speeds is caused by a decrease in the primary peak current that the contacts interrupt. The peak current decreases with an increase in cam speed because the saturation period of the coil is shorter at faster speeds.

The curve in Fig. 9 shows the change in the frequency of the primary voltage oscillation when various condenser capacities were used across the contact points, the frequency being lower at the larger condenser capacities. This frequency of oscillation is a measure of the time required for the coil to discharge into the condenser, therefore, the peak voltage across the contacts decreases with an increase in condenser capacity because it takes a longer period of time for the discharge to occur.

B. Material Transfer to the Negative Contact

When condenser capacities larger than 0.18 mfd. were used in this circuit the contact material transferred from the positive contact to the negative contact. From the curves of peak voltage and the frequency of the primary oscillation the rate of increase of the primary peak voltage has been determined for the various condenser capacities and are plotted in Fig. 10. Since the rise in voltage is much slower at the larger condenser capacities and there is very little visual arcing between the contact points, it is believed that the negative transfer results from a phenomenon occuring when the current through the points is interrupted at a voltage lower than 15 to 18 volts which is approximately the lowest value at which a d.c. arc can be maintained in air between tungsten contacts.

At the larger condenser capacities the lower rate of increase of the primary voltage allows the contacts to separate sufficiently far before voltages above 15 to 18 volts are reached and the larger voltages have little effect on the transference of contact material.

C. Material Transfer to the Positive Contact

When condenser capacities lower than 0.15 mfd. were used across the contact points, at the low cam speeds there was a tendency to get large transfers of contact material from the negative contact to the positive contact. The rate of rise of the primary voltage is much faster at the low condenser capacities than at the high condenser capacities, and as is shown in Fig. 9, the peak voltage is greater at the lower condenser capacities, therefore, the contact opening will be much smaller when the higher voltages develop between them.

The oscillographic observations showed that when the 0.113 mfd. condenser was used across the contact points and the cam speed was 400 r.p.m., there was a regularly occuring discharge from a peak voltage of 328 volts, as shown in Fig. 7. The minimum voltage which will break down the shortest gap in air is approximately 320 volts. Under these conditions, the wave front of the voltage is sufficiently steep to break down the gap

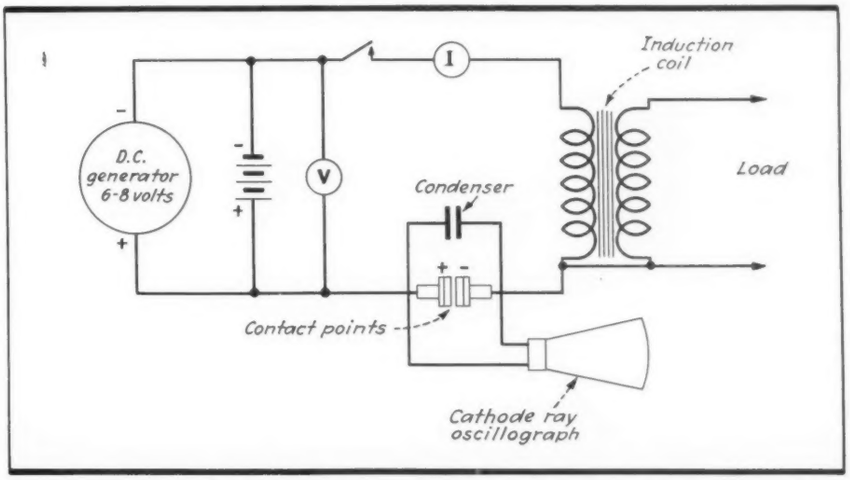


Fig. 6—Circuit used to study the effect of various condenser capacities across tungsten contact points

between the points which produces a large transference of contact material from the negative contact to the positive contact. At 650 r.p.m. cam speed the peak voltage had decreased to 320 volts, the points were separated farther at the voltage peak and the wave had assumed the shape of a regular oscillation with no indication of a discharge of the condenser from the high voltage.

When a 0.052 mfd. condenser was used across the contact points and the cam speed was 400 r.p.m. there were three high voltage discharges from a peak of 352 volts before the regular oscillation of the wave occurred, and this condition produced more pronounced large positive transfer along with considerable oxidation of the contact surfaces. At 800 r.p.m. there was one discharge from 335 volts and at 925 r.p.m. the discharge had completely disappeared and the peak had dropped to 322 volts.

D. Phases Contributing to the Balance of Negative and Positive Transfer

When this particular circuit is made to operate with condenser capacities between 0.16 and 0.18 mfd. the transfer of contact material is usually relatively small and is probably the result of various phenomena which occur almost simultaneously. At the instant the contacts separate the first phase that occurs is the low voltage discharge from below 15 to 18 volts which causes pronounced negative transfer as already described.

On further separation of the contacts, the second phase that will exist is that of an unstable arc when the primary voltage reaches 15 to 18 volts. The severity of this phase increases with an increase in current interrupted by the contacts, with an increase in the rate of rise of the primary voltage caused by the lower condenser capacities and with a decrease in the rate of separation of the contacts. This condition causes erosion of the negative contact and a tendency for transference to the positive contact which would probably be masked by oxidation. If the effect of this phase is only slight as is usually the case, it will tend to reduce the negative transfer created by the first phase and produce a slight oxide ring on the positive contact. At high contact current and slow separation of the contacts this phase may become severe and cause excessive oxidation of positive contact.

A third phase which definitely appeared in the oscillographic wave was an occasional discharge from voltages varying between 255 and 20, depending upon cam speed and condenser capacities used. This phase has the appearance of a condenser discharge because of a reclosure of contacts resulting from mechanical chatter. It occurs at lower voltages with an increase in cam speed and also at lower voltages with an increase in condenser capacity. Both conditions indicate that the discharge varies as a function of time depending upon speed of the cam and it occurs at the same time intervals at which mechanical chatter has been measured. This phase causes roughening of the contact faces producing a gray contact area and causing some transfer to the positive contact. This third phase will tend to reduce the negative transfer created during the first phase and cause an increase in the active area of the contacts.

The fourth phase, which probably exists, but which would be impossible to detect on the oscillograph, is a sputtering of material from the cathode which will transfer to the anode because of the polarity of the voltages. When an unstable arc is interrupted or when a condenser discharge occurs because of chatter, it is probable that the air gap between the contacts will become sufficiently ionized for conduction to take place between the contacts as the voltage rises to its peak value, and this phenomenon will cause a sputtering of cathode contact material which will transfer to the anode. This condition will be the most pronounced at low cam speeds and with the lower condenser capacities for the conditions are more favorable for ionization of the air gap and the higher values of voltage occur at smaller gap openings.

To obtain the most satisfactory operation of the contacts it is necessary to balance the circuit conditions so that the phases which cause positive transfer are of the proper degree to counteract the tendency of the low voltage stage to produce the negative transfer. Balance can be obtained by the proper selection of inductance and capacity in the circuit. It is highly undesirable to permit the occurrence of the spark stage which exists when the peak voltage exceeds the minimum breakdown voltage of an air gap because this condition causes excessive positive transfer and resultant contact failure.

The important factors to consider in order to obtain good contact performance when designing a piece of apparatus are:

(1) The allowable current that a pair of contacts can safely interrupt varies inversely with impressed voltage and frequency of operation.

(2) The spacing and the rate of separation should permit the contacts to separate sufficiently far before the higher peak voltages develop between the contacts.

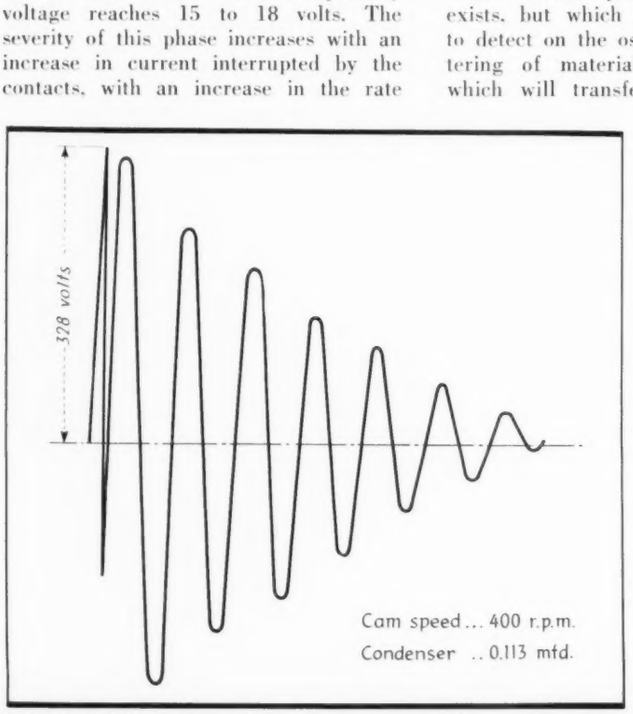


Fig. 7—Oscillographic voltage wave produced when contact points are separated

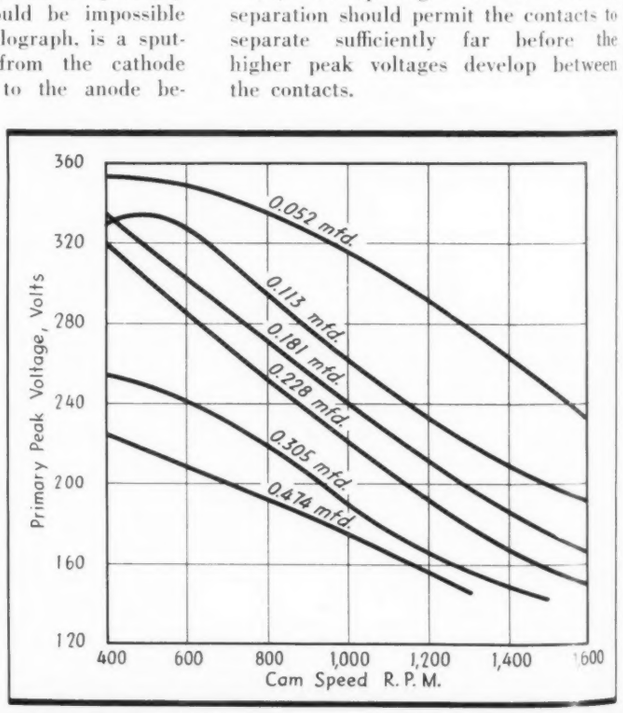


Fig. 8—Curves showing primary peak voltage for different cam speeds and various condensers

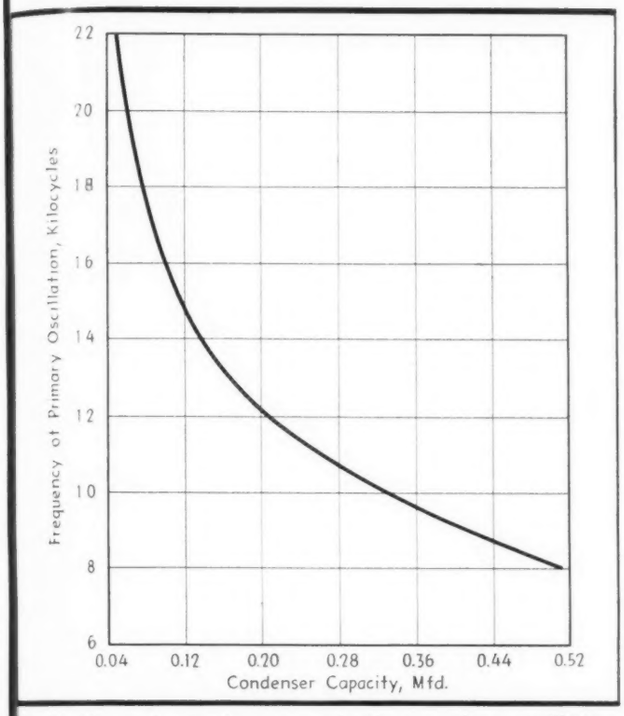


Fig. 9—Change in the frequency of primary voltage oscillations when various condenser capacities were used across contact points

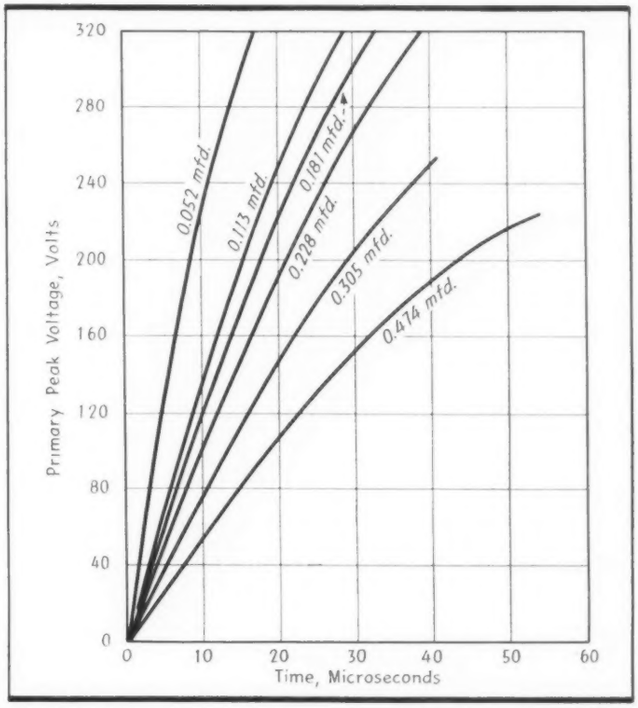


Fig. 10—Rate of increase of primary peak voltage for various condenser capacities

(3) With a condenser across the contacts, the rate of rise of primary voltage for the factors causing negative and positive transfer should be in balance. There will be some visible arcing between the contacts at this condition.

(4) Care should be taken to eliminate excessive chatter or mechanical action.

(5) The contact pressure should be sufficient to assure a good contact, for tungsten this should be 5 oz. or preferably higher.

(6) A radius face contact, of a size to insure sufficient contact area, operating against a flat face contact facilitates good contact alignment.

(7) A wiping action is not particularly desirable with tungsten contacts, as a small build-up will interfere with their proper opening. It should also be noted that:

Transfer is a directional phenomenon, associated with d.c. circuits

As the inductance decreases, the transfer height increases

Low contact pressure decreases transfer but increases the liability to inconsistent performance

The voltage drop effect of persistent oxides is increased at low contact pressures

It is possible to decrease transfer by using certain silver alloys.

Relays and devices such as railway signal relays and (low voltage) voltage regulators controlling d.c. circuits, have been developed which are precision instruments in the sense that they work at low contact pressures, high contact frequencies are upset in calibration by either transfer or high contact resistance, and operate on lightly inductive loads.

The problem of developing a contact material for these devices was accentuated by the fact that the overall cost must be low. This ruled out the use of noble metals and their alloys.

The first part of the problem to be solved was reduction of transfer to a low value, certainly less than 0.002 in. over a period of 1,000 hours' operation of the contacts. Alloys of silver were tried. The results of these tests indicated that the most likely alloys for use were those which had low transfer tendency and which produced oxides that were either conducting or easily reduced in the heat of the arc. None of the materials tried, however, would be entirely reliable in long service because of erratic behavior after short time periods.

With this in mind, and knowing that contact resistance was a large factor in performance, it became necessary to center attention on alloys having a low transfer tendency, a conducting oxide, or a heat-reducible oxide.

A fourth element in the problem, mainly responsible for the solution, was recognition of the fact that the transfer was directional. That is, material was transferred from the positive contact.

Therefore, if the positive contact was made of material which had a low transfer tendency, the transfer would be halted at its source. Perhaps a material could be used on the negative contact which would contribute to low contact resistance. For example, pure silver might, theoretically, be used in that position.

As mentioned in Part I, an alloy of Ag-Cd-Ni has very low transfer tendency. In addition, cadmium oxides are unstable in presence of heat. Accordingly, the positive contact was made of this alloy and operated on test against fine silver as the negative contact. This gave the most satisfactory performance up to that time, but on extended life test it was not fully reliable. Using this same principle, approximately forty combinations were tried, with the final result that Ag-Cd-Ni was evolved as the positive contact material against Ag-Pd (Elkonium 17-11, U.S. Pat. No. 2,151,905) as the negative contact. The particular combination developed somewhat exceeded the performance anticipated.

It was also found that the positive contact retained its shape and dimensions during long test periods. This has been explained by means of annealing tests of the Ag-Cd-Ni alloy which showed that the Ni is responsible for maintaining the hardness of the alloy at elevated temperatures.

This combination of materials has also been used successfully on resistive load applications with minor changes dictated by the difference in behavior of the subject alloys on resistive loads as contrasted with inductive loads.

The authors wish to acknowledge the valuable help and guidance from Mr. J. A. Weiger, Vice-President, and Dr. F. R. Hensel, Metallurgical Consultant, of P. R. Mallory & Co., Inc., and to express their appreciation to Mr. J. E. Cain, Executive Vice-President, for permission to publish this article.

MOTOR PROTECTION

Built-In Thermal Devices for Small Motors

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Spencer Thermostat Company

IN OVERLOAD PROTECTION, the immediate concern is the limitation of stator winding temperature. Of the three basic causes for stator winding overheating, namely high ambient temperature, continuous overload, and overheating caused by stalled rotor or prolonged running on starting connection, only the last two are the result of high current flowing through the winding. Evidently for complete protection against any one or a combination of these causes, the protective device must be actuated by both the current flowing through the stator and the stator winding temperature.

Stator current can be limited by external remotely-located overload protectors, such as solderpots or switches using low melting alloys, magnetic switches, and fuses, the oldest form of motor protection. Such devices although designed in part to follow the heat curve of the motor, respond primarily to the effects from the current that is flowing, being unaffected by ambient temperature at the motor. Thus external devices do not protect the motor against overheating as such, but protect only against excess motor current flowing for an appreciable duration of time. They offer no protection against overheating caused by repeated starting, high ambient temperature, or prolonged operation at maximum current. This last is significant in that the external protective device must of necessity be set high enough to carry starting current which is higher than the maximum allowable continuous running current. A motor becoming heated through improper ventilation will not have its heated condition duplicated in a remote protector. Also, it is usually impossible to work to the maximum power output with complete safety and freedom from unnecessary shut-down.

Internal protection can be obtained by the use of bimetallic devices, such as strips and disks, and by low melting alloy solderpot devices. The bimetallic type and the solderpot type can be selected to operate by temperature or by the current through the motor. The bimetallic devices also offer the possibility of operation on the combination of motor temperature and winding current, and in this way will offer protection to the motor against all three overheating causes enumerated previously.

The curves show that the ideal situation is one wherein the thermal protector will operate principally from motor heat up to about 250 per cent load and beyond that point will be actuated primarily by a properly proportioned auxiliary heater in the motor winding circuit.

Of the several types of inherent thermal protectors available, all of which work on the same basic principle of duplicating the heat of the motor, the bimetal disk type has the feature that the thermally-actuated element is itself the snap-acting switch member. The disk consists of bimetal shaped like a dish with the high expansive side the concave part at normal temperature. When the disk is heated, the concave part attempts to expand, but is restrained by the low expansion metal on the opposite surface. This action builds up stresses in the disk which culminate in a complete buckling or instantaneous snap when the pre-determined temperature setting is reached. The disk snaps at a speed of the order of the muzzle velocity of a rifle bullet and requires only 0.00016 sec. to complete the snap. When the disk cools it returns to its original position in the same manner and at a pre-determined fixed temperature. The operation of the disk is therefore a snap-action at fixed temperatures. For one-way operation, as in a manual reset device, the reclosing temperature is fixed at an extremely low value.

In construction of the protective device, the disk is mounted in a plastic base with the auxiliary heater element and wiring connections recessed in the base. The contact buttons are welded directly to the disk and the only moving part of the whole device is the disk itself with the attached contacts which make and break the circuit.

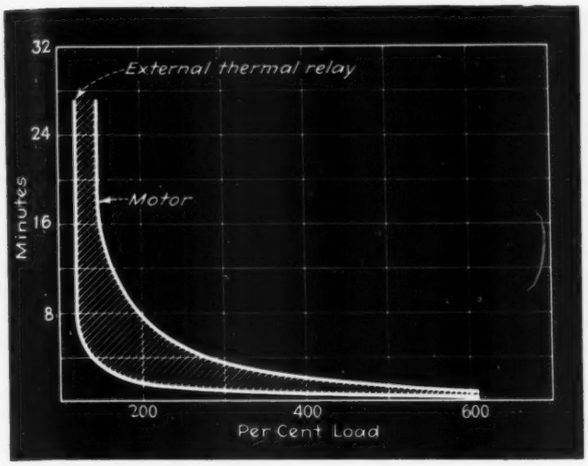
Built-in disk protectors receive part of their functioning heat from the motor, part from the auxiliary heater under the disk, and part from the heat generated from the disk itself by the current flowing through it. These proportions vary with different types of protectors to meet varying motor conditions. In all cases, however, the purpose of the auxiliary heater is to compensate for rapid heat rise in the motor winding in relation to heat rise in the frame.

To test for the proper relationship between auxiliary heater and conducted heat, the motor is gradually loaded to a point where the winding and frame temperatures reach the safe maximum value. This maximum safe temperature is usually 105 deg. C., and varies according to the class of insulation used. Under the above test conditions, the temperature rise supplied by the current passing through the protector is small in relation to the temperature rise conducted to the protector by the motor itself. Temperature rise in the motor windings is at a slow rate and is conducted to the motor frame at approximately the same rate of temperature rise as in the windings themselves. When the motor load is greater, the difference between winding temperature and frame temperature becomes greater and reaches maximum condition on stalled rotor. Thus the heat generated by the current passing through the auxiliary heater and the disk in the protector will keep the temperature of the disk up to that of the windings.

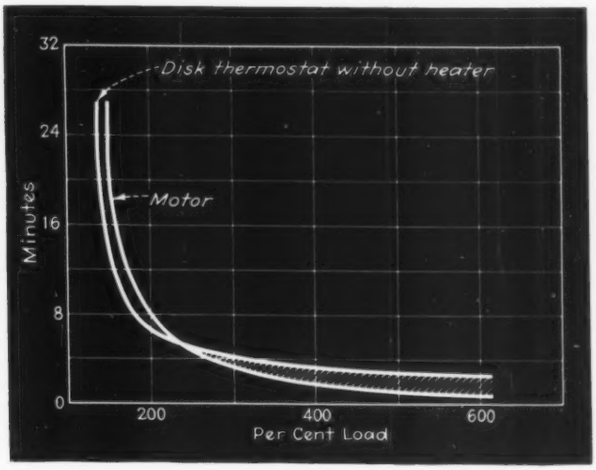
The characteristics of the protectors may be varied by changing the material in the disk, thus altering both its resistance and temperature of actuation, or by using different types and sizes of auxiliary heater.

In the large group of fractional horsepower motors, from ¼ hp. up to 1 hp., single phase, 110-220 volts, it can be assumed that the heat characteristics of split-phase motors, capacitor-type motors and repulsion-start induction motors follow nearly the same curves. Open-type motors in the above group receiving a constant air circulation from outside, have a somewhat lower temperature condition under normal operation than do totally-inclosed motors. For this reason, two standard opening temperature settings, 105 deg. C. and 120 deg. C., are generally used in specifying thermal protectors.

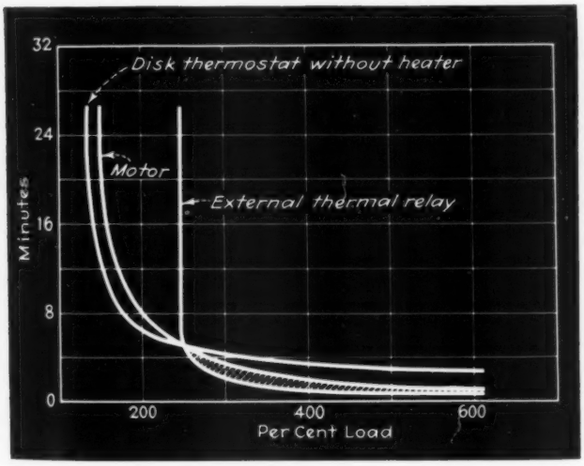
For instance, the characteristics of a 1-in. diameter disk protector are applicable to all motors which can stand a maximum of 20 to 30 sec. locked rotor. This is true of practically all split-phase or condenser-type motors and their characteristics can ordinarily be matched either by 105 deg. C., or 120 deg. C. protector. Variations in characteristics



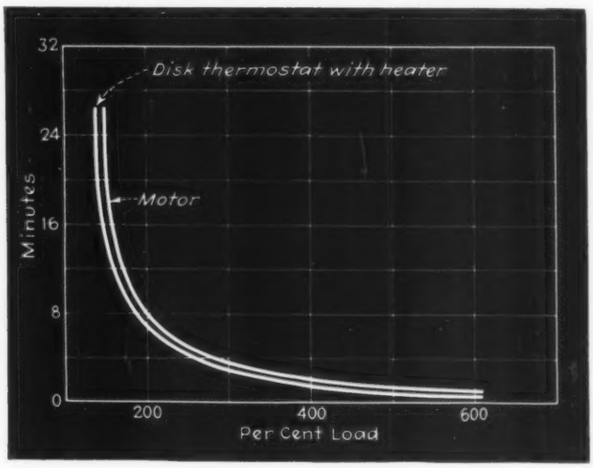
Remote protection provided by a current limiting relay. The shaded portion represents unused motor capacity. At 200 per cent load, while the relay will trip in less than 2 min., the motor actually does not reach its danger point for 8 min. Motor could operate for an additional 6 min. at 200 per cent before reaching a dangerous temperature.



Built-in bimetal protection, operating on motor temperature alone, mounted directly on the motor. The two curves follow each other closely to about 250 per cent load, beyond which point the heat-conductivity from the motor to the thermostat is too slow to give proper protection. The shaded portion indicates the zone in which no protection is afforded.



Combination of an external thermal relay with a built-in bimetal thermostat. The relay is designed to trip at 250 per cent load, at which point the thermal device offers close protection. Beyond that point, protection is afforded by the external thermal relay, but the shaded portion represents the zone of over-protection or unused motor capacity.



Built-in thermostat with an auxiliary heater through which the motor current flows. Up to about 250 per cent load, this protector follows closely the temperature of the motor and from this point on receives the actuating heat from a properly proportioned auxiliary heater incorporated in the protector. The two curves are practically identical.

can be met by supplying a proper size auxiliary heater.

By reference to the portion of a standard 1-in. disk motor-protection thermostat chart, it will be noted that at room temperature, approximately 25 deg. C., with a current of 25 amp. passing through the protector, type *A* will open in 1 sec.; with a current of 22 amp. in 2 sec.; and with 18.25 amp. in 30 sec. These values will be found under the general heading "Current values for various release times from 25 deg. C." Under the column headed "Maximum amperes on locked rotor," it will be noted that 29 amp. is listed as being the maximum current value which this particular protector with heater can safely handle. Under the heading "Ultimate trip amps.", the columns headed "At 90 deg. C.", "65 deg. C.", "25 deg. C.", tabulate the current values which will trip this protector at these different motor temperatures. This protector will permit up to 9.67 amp. at room temperature (25 deg. C.) to pass continuously without tripping. Under a 40 deg. C. temperature rise, or at 65 deg. C., this current value is reduced to 7.25; at 90 deg. C. and 5.3 amp., the motor will be taken off the line by the protector.

Protectors should be available in both automatic and manual reset types and should be interchangeable and identical in protection characteristics in order to be adaptable to the wide variety of motor uses. Motors used on applications where no dangerous conditions would exist as a result of the motor restarting automatically, call for the automatic reset type. For example, refrigerator com-

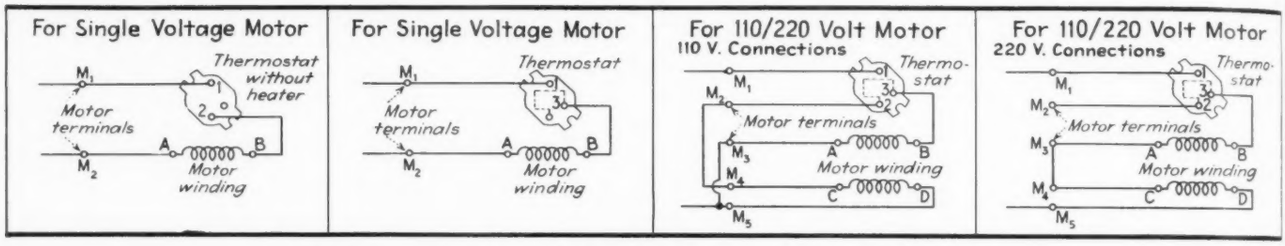
pressors, air pumps, water pumps, and in general most of the unattended and automatically controlled motor applications use this type of protector. On the other hand, power-driven saws, meat choppers, grinders and many other machines would be definitely dangerous if arranged to restart suddenly without warning. On an oil burner, manual reset is needed to insure a sufficient time delay before restarting.

Mounting

Inherent thermal protection requires that the protector be placed in intimate contact with the motor. Point of application is inside the motor close to the source of heat.

It might be argued that if the inbuilt device is connected in the grounded motor lead, as it may be without polarized plugs or permanent wiring, then a ground on the motor will permit current to flow through the part of the motor winding ahead of the ground. This could cause over-heating from excessive current or burning out of the motor, as the element would be effectively by-passed but the likelihood of the ground being just enough to cause a current more than the motor can stand but not enough to blow the line fuses is so remote as to be hardly worth consideration. The line fuses are depended upon to protect the motor and the circuit from short-circuit current with any type of protector.

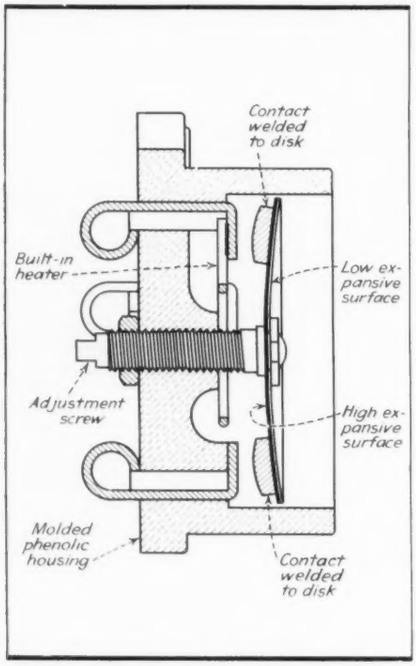
Built-in protection may be impractical on the smallest motors because of its size; on small orders for special motors where the cost of providing for the protective device would be excessive, or where the engineering cost of determining its specifications would be high. It is also superfluous on some shaded pole and some capacitor motors which are designed to withstand stalled rotor condition without burnout.



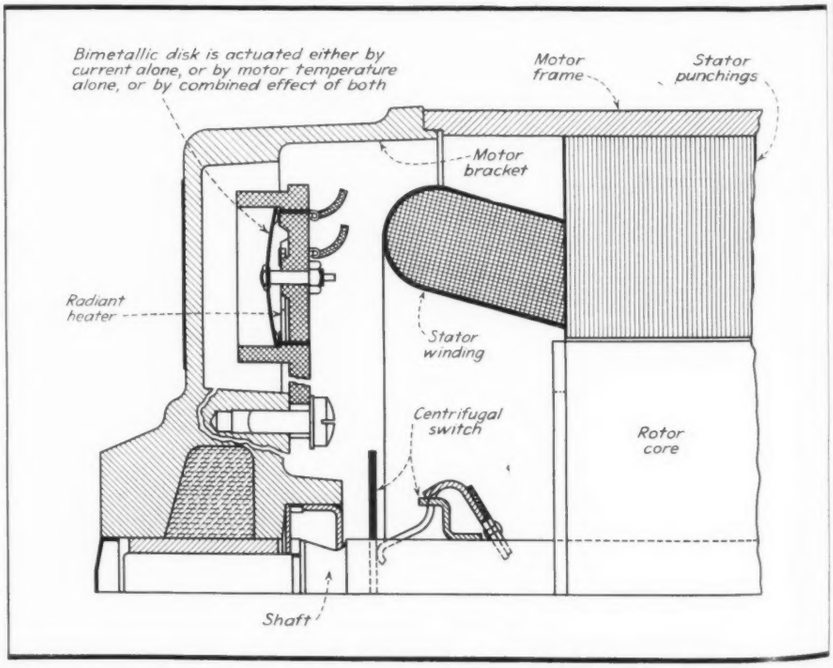
Wiring connections for built-in disk thermostat, with and without heater

SELECTION CHART —— 1-INCH DIAMETER DISK

Type	Ohms Resistance	Ultimate Trip Amps. at			Max. Amps on Locked Rotor	Current Values for Various Release Times from 25°C						
		90°C	65°C	25°C		15 Sec.	20 Sec.	30 Sec.	40 Sec.	60 Sec.	80 Sec.	120 Sec.
A	0.0576	5.3	7.25	9.67	29.0	25.0	22.0	18.25	16.5	14.75	13.5	12.0
B	0.0522	5.3	7.2	9.4	23.0	22.5	21.0	17.9	16.4	14.75	13.5	12.0
C	0.0693	4.71	6.39	8.5	23.0	20.5	18.75	16.0	14.5	12.75	12.0	10.6
D	0.0773	4.55	6.2	8.2	21.0	20.25	18.25	15.7	14.05	12.4	11.5	10.0
E	0.0795	4.4	6.0	8.0	29.0	22.5	19.5	15.8	14.75	12.5	11.35	10.2
F	0.0839	4.4	6.0	7.9	20.0	18.8	18.0	15.5	14.0	12.4	11.5	10.0



Sectional view of the 1-in. disk protector, showing method of mounting disk on adjusting screw set in plastic housing. Radiant heater is recessed in base



Recommended method for mounting a 1 in. disk-type protector. It is mounted in a recess in the motor casing, the same recess serving for either the automatic reset or the manual reset type. For the latter it is only necessary that a hole be provided for the reset button. Pattern changes to accommodate the protector are comparatively inexpensive

Question and Comment

Backlash Not Involved in *C* Value of Gears

ARTHUR L. WILDE
Wethersfield, Conn.

In the February number of *Product Engineering*, Page 53, Mr. A. C. Rasmussen presents an interesting development of the method of calculating the strength of gear teeth first presented in 1931 by Prof. Earle Buckingham.

However, the writer believes that Mr. Rasmussen has made an error in his interpretation of the original formula for obtaining the increment load. The original paper was presented in May, 1931, and later condensed versions were published several times. In all of these reference is made to the increment load as being the result of errors of form or spacing of the involute teeth, and values are given for a factor called *C* which are directly proportional to the maximum combined error of any two teeth in mesh. This is obviously the sum total of involute and spacing errors for any two teeth in a given pair and it is these errors which cause the variation in the velocity of the driven gear and result in the increment load.

Mr. Rasmussen seems to have misread the original matter and has assumed that the *C* value is dependent on the backlash, but the writer has not found in the original paper or any later copy, any reference to backlash as affecting the increment load. Most often the backlash is far larger than the total tooth profile errors and neither one has any relationship to the other except that in rough cut gears the backlash is usually made greater than in carefully cut or ground gears, thus making the two factors somewhat proportional. It therefore seems to be a distortion of the line of reasoning used in developing the original table of *C* values, to use the backlash instead of the tooth profile errors.

From another viewpoint, however, there is some logic in associating backlash with increment load. This might exist in the case of a highly fluctuating load such as a drive to a multiple step heavily loaded relieving cam, a wide straight tooth milling cutter or a thread hob. In such a drive, connecting a variable loaded driven member to a drive gear having a relatively large mass or flywheel effect, if the backlash in the entire train were held very low it would minimize the extent of the variation in rate at the driven point and thus would seem to keep down the increment load. However, the original Buckingham paper states that the information is intended to cover the average conditions, which may be assumed to mean a steadily applied load such as would hold the teeth closely in mesh even if the backlash were as much as, let us say, 1/8 of the circular pitch.

Torsion Spring Design

(Editor's Note: The first part of this article, presented in May Product Engineering, page 208, derived the fundamental

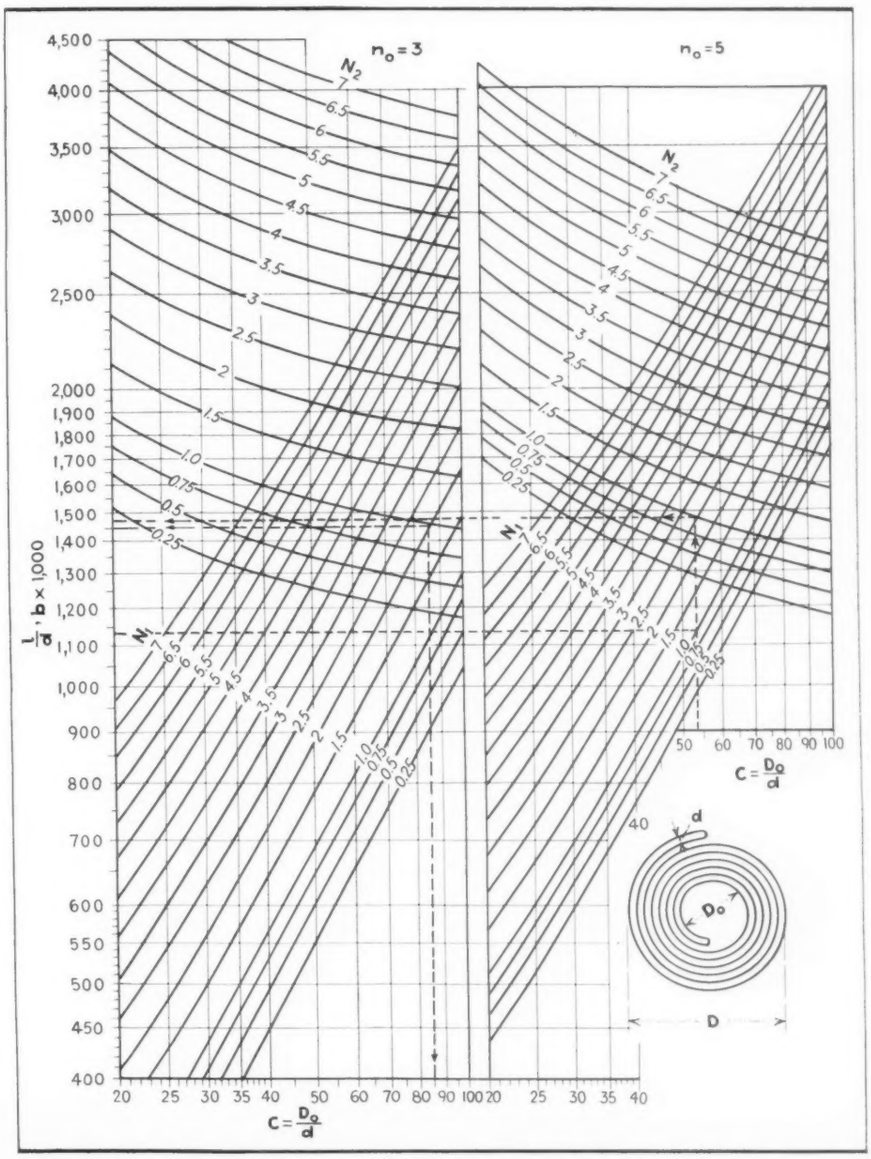


Fig. 3—Determination of D_o and n_o in torsion spring design

equations, and included tables and charts necessary for the graphical design method.)

Example II. A spiral spring suitable for back stroke of the power registering apparatus drum. 1 complete turn $N = 1$, $\theta = 360$ deg. respectively, to be developed by the spring. The following restrictions to be observed: the spring must be placed when free into the barrel having an internal diameter $D = 7$ in. The theoretical maximum torque $M = 4$ in. lb. Using standard cold drawn wire (material *A*) and selecting factor of safety $K = 3.5$, we obtain $km = 14$. Using the chart Fig. 4, trace horizontally from the point on the left hand vertical scale designating $km = 14$ to the heavy line *A*. The intersection thus obtained will indicate on the top scale the nearest standard size of spring wire $d = 0.08$ in. and on the bottom scale a corresponding W & M gage 14. Then trace horizontally from the point on the left-hand vertical scale designating $\frac{M}{\theta} \times 100 = \frac{400}{360} = 1.11$, and vertically from the point on the bottom scale corresponding to gage number 14. The intersection of both lines will indicate a sloping line representing value of $\frac{l}{\pi} = 29$. Thus $l = 3.14 \times 29 = 91$ in.

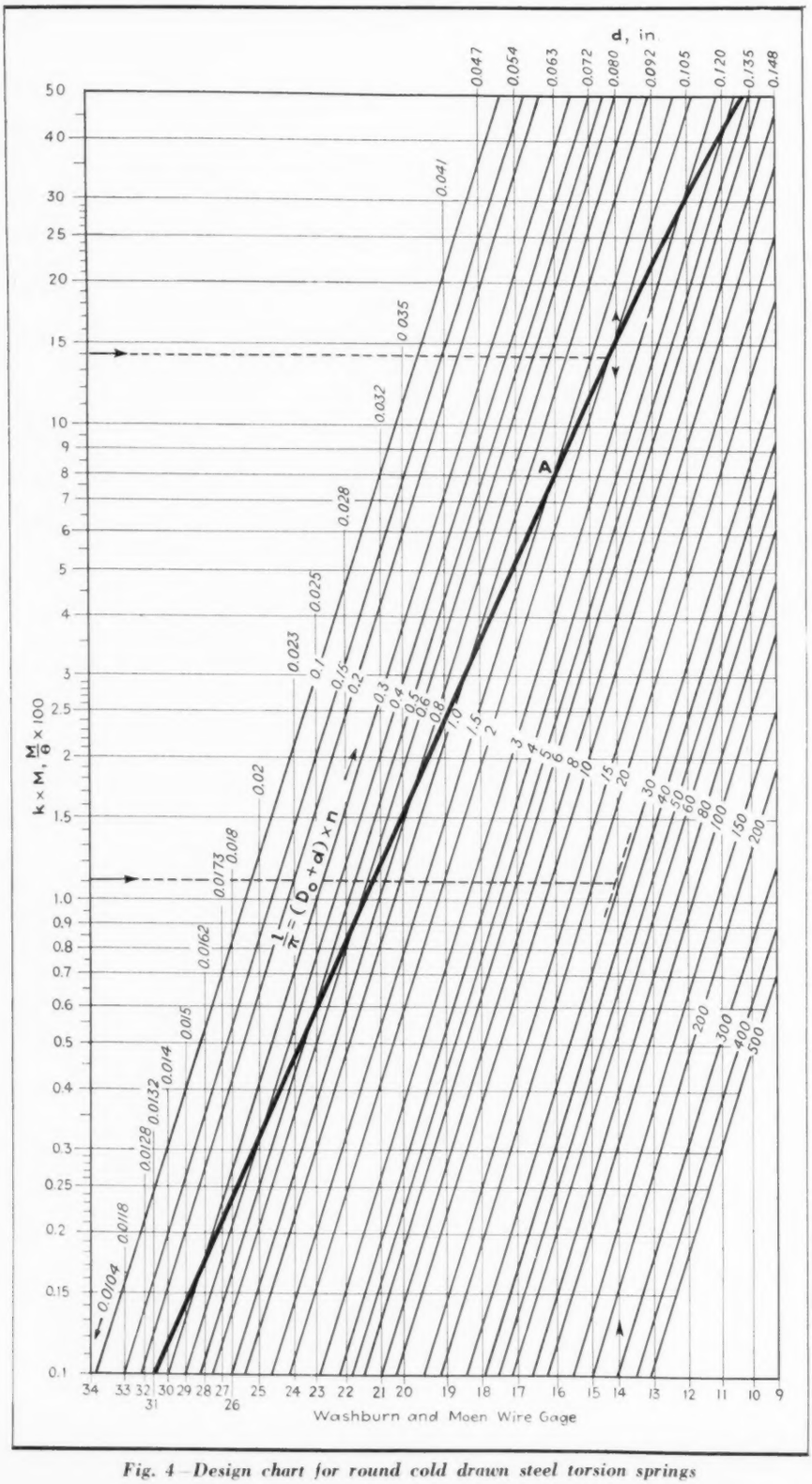


Fig. 4—Design chart for round cold drawn steel torsion springs

For determining true number of turns of the spring when free and the diameter of shaft D_o use the chart, Fig. 3. Select previously $n_o = 3$. Trace horizontally from the point on the left-hand scale $\frac{l}{d} = \frac{91}{0.08} = 1{,}137$ to the sloping line marked by $N_1 = 1$. The vertical line traced from the point of intersection thus obtained will indicate on the bottom scale value of $C = 8.5$. Thus $D_o = c \times d = 6.8$ in. The outside diameter of the spring will be obtained by tracing vertically from the point on the bottom scale designating $C = 8.5$ to a curve marked by $N_2 = 1$. The point of intersection will then indicate on the left-hand vertical scale a corresponding point $1{,}450 = 1{,}000 \times b$.; thus $b = 1.45$ and $D = 6D_o = 9.88$ in. Using the graphs constructed for $n_o = 5$ and proceeding as before, we obtain: $c = 53.5$; $D_o = 53.5 \times 0.08 = 4.28$ in.; $D = 1.475 \times 4.28 = 6.3$ in. Interpolating values of D equal to 9.88 and 6.3 we are able to select a number of turns N_o corresponding to the outside diameter of spring specified. i.e. 7 in. Thus $n_o = 5 - (5 - 3)\frac{7 - 6.3}{9.88 - 6.3} = 4\frac{1}{2}$. Then $b = 1.45 + (1.475 - 1.45)\frac{5 - 4.5}{5 - 3} = 1.456$

$$D_o = \frac{D}{b} = \frac{7}{1.456} = 4.8 \text{ in.}$$

Assuming $\frac{3}{4}$ turns ($\theta = 270$ deg.) instead of 1 turn to be developed by the spring at the same torque $M = 4$ in. lb., and proceeding as above we obtain: with $n_o = 3$; $l = 69$ in., $D_o = 5.12$ in., $D = 8.63$ in. outside diameter. With $n_o = 5$, $l = 38.5$ in. $D_o = 3.08$ in., $D = 4.83$ in. outside diameter.

—Victor Tatarinoff
Pilsen, Czechoslovakia

Chute Trouble Ended

To the Editor:

I recently ran across an item at the Packaging Show which may interest other designers. A machine which used gravity to slide cans down a chute was having

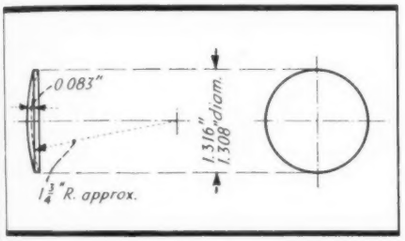
a little trouble with the cans slowing up and bunching together. The engineer later told me that the problem was solved by cutting holes in the chute to lessen the area of contact between the cans and the slide, thus reducing the force tending to stop the cans.

—Ed West
Chicago, Ill.

What Pressure?

To the Editor:

We have a job in our engineering department which requires that we insert, without a sharp blow, a plug of the type shown. Assuming that the hole is to the high limit of the plug, can you give me a formula to calculate the pressure necessary to press the plug flat so as to develop maximum pressure against the wall of the hole? This plug is made



from sheet steel, S.A.E. 1020 analysis, blanked and formed on a punch and die.

—Pierre C. Perrine
Connersville, Ind.

As Easy As *A, B, C?*

To the Editor:

The writer has originated a somewhat unusual problem which may be of interest to your algebra and puzzle fans.

Three men, *A*, *B*, and *C*, each have a square garden. Each side of *B's* garden is one foot longer than *A's* garden. Each side of *C's* garden is one foot longer than *B's* garden. The combined area of *A's* garden and *C's* garden is two sq. ft. more than twice the area of *B's* garden. What is the length of one side of *A's* garden?

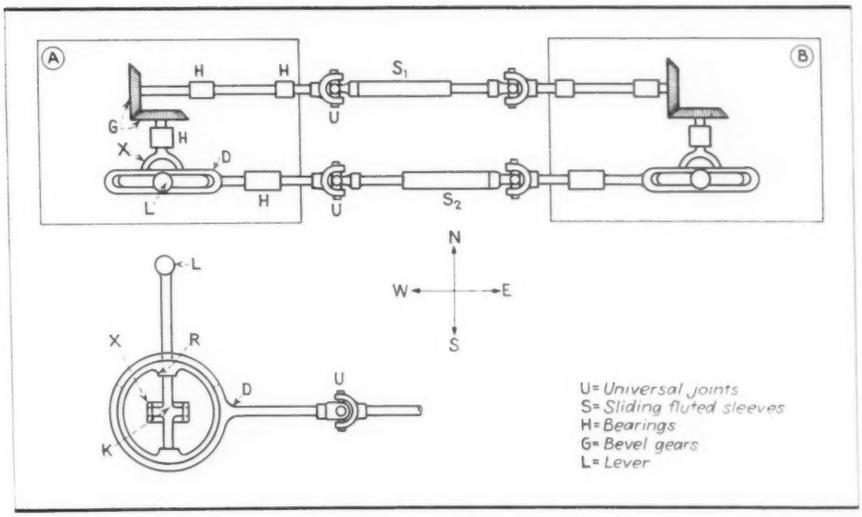
—Ernest W. Davis
River Forest, Ill.

Duplicating Motion

To the Editor:

While looking through the February issue of Product Engineering recently I noted on page 78 a problem by Henry Bohn of Schenectady, N. Y., who wants a method of duplicating motion on two independent objects. He gave as an example a lever on one freight car producing an exactly similar motion in a lever on another car through some sort of connecting mechanism entirely independent of the motion of the two cars.

If I understand his problem correctly,



perhaps the above diagram will serve as a suggestion to Mr. Bohn. In brief, the mechanism illustrated consists of two linkage systems, one for each direction of movement of the lever. These systems are connected between the two independent objects, *A* and *B*, by universal joints and sliding fluted sleeves which allow *A* and *B* to move relative to each other without affecting the motion of the levers.

Here's how it works. Motion of lever *L* on object *A* in an east-west direction rotates internal ring assembly *R* within ring part *D*, turning shaft *X*. The lever slides in a slot in *D*, which remains stationary. The motion of *X* in turn is transmitted through the gears, universal joints and sliding sleeve S_1 to similar parts on object *B*. When the lever on *A* is moved from central position in a north-south direction, the entire ring assembly rotates around the center of shafts *D* and *K*, leaving part *X* stationary. The motion of the lever is transmitted through *D*, the universal joints and S_2 to similar parts on object *B*. Compound motion of lever *L*, let us say in a northeast direction, moves both of the linkage systems, and produces a northeast movement of the lever on *B*. Thus any motion of *L* on *A* is exactly reproduced in the lever on *B*, regardless of the relative position of *A* and *B*.

Care should be taken that the spiders on the universal joints are in the same relative positions, and objects *A* and *B* should move in parallel planes.

—Anton Kronstedt
Minneapolis, Minn.

Can You Work This One?

H. E. SMITH

Solution to May problem—

Canny Measurement

14 Quart	5 Quart	9 Quart
5	—	9
5	5	4
10	—	4
10	4	0
1	4	9
1	5	8
6	—	8
6	5	3
11	—	3
11	3	—
2	3	9
2	5	7
7	—	7

A milkmaid was faced with the problem of dividing 14 quarts of milk into two equal parts, using only the full 14 quart container and two other cans, 9 and 5 quarts, respectively. After lengthy cogitation, she succeeded in doing the task in the above thirteen steps.

This month's problem—

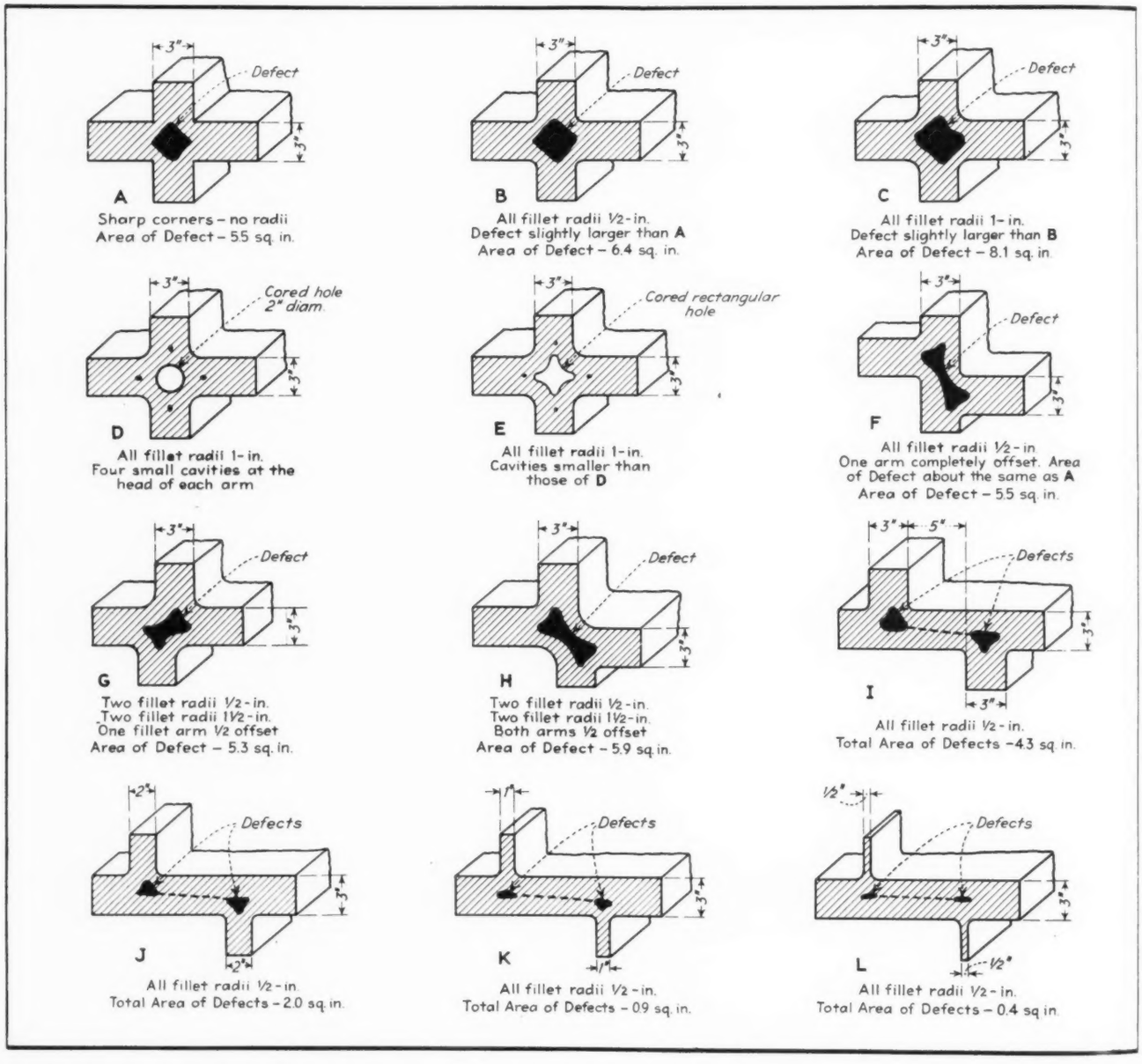
Mixing Drinks

A man, obviously a poor judge of servants and wines, bought a 30 gal. keg of diluted wine which was 60 per cent water by volume. Subsequently his servant developed the bad habit of sneaking down to the cellar and drawing a gallon of the barrel's contents for his own use. Each time, to cover up his guilt, he refilled the barrel with a gallon of water. One day, the master went to the cellar for some of his wine and discovered that the wine content of the keg was only one half of one per cent. Assuming perfect mixing, how many drawings had the servant made?

STEEL CASTINGS

RESULTS of studies covering "L" and "T" connections of various designs were presented in the May *P.E.* number. In this part of the article the results of studies of "V" and "X" sections are presented. An analysis of the assembled data suggests the following rules for good steel casting design:

1. An attempt should be made to design all sections in a casting with a uniform thickness.
2. It is not desirable to design structures with abrupt changes in section.
3. Sharp corners at adjoining sections are sources of defects and if possible should be eliminated.
4. When a design of a cast steel structure becomes complicated or intricate it is suggested that the design be broken up into parts which may be cast separately and then assembled by welding.
5. In designing unfed adjoining sections in "L" or "V" shapes, it is suggested that all sharp corners at the junction be



"X"-sections, it will be seen from the above studies, cannot be designed that are free from a contraction cavity if the section is fed only through the arms. The defect can, however, be made quite small by designing the section with a cored hole. Designs formed by offsetting the arms of the "X" have defects that are about the same size as those appearing in the usual "X" type section. A section having one arm completely offset, allows the foundryman to use external chills to advantage. Slightly better results can be obtained by spacing the offsets further apart in order to allow the foundryman ample freedom for the placing of external chills. The illustrations show how the defect may be decreased in size as the adjoining section is decreased. Unless it is advantageous to use the cored hole at the center of the hot spot it is suggested that one arm be offset similar to that shown in the *I* design in order to minimize the defect as much as possible

NDESIGN FEATURES—II

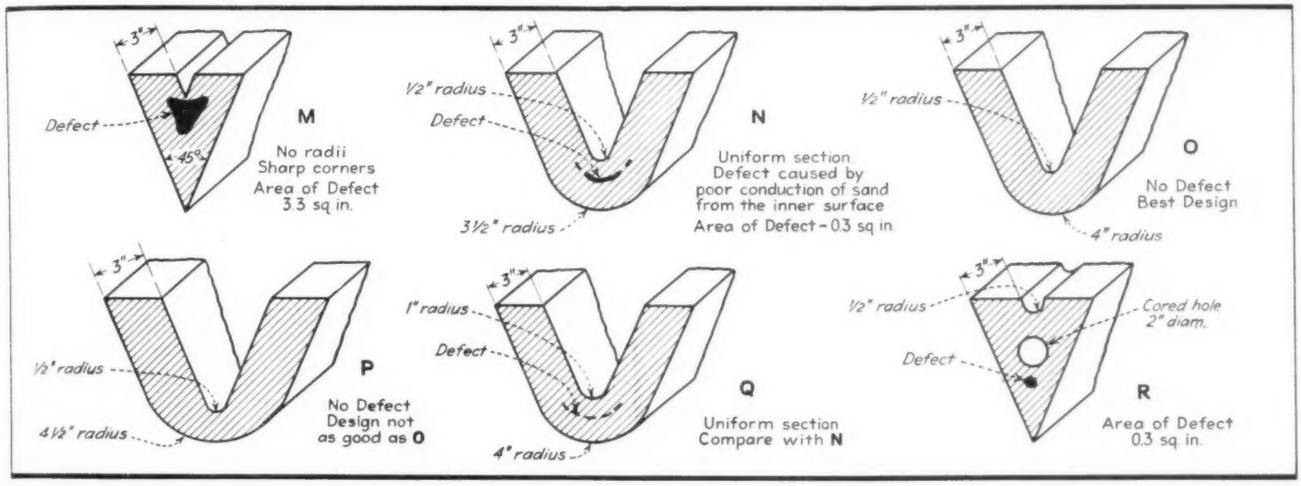
replaced by radii so that the junction section becomes slightly smaller than that of the arms.

6. In designing sections that join in an "X"-section, it is suggested that two of the arms be offset considerably.

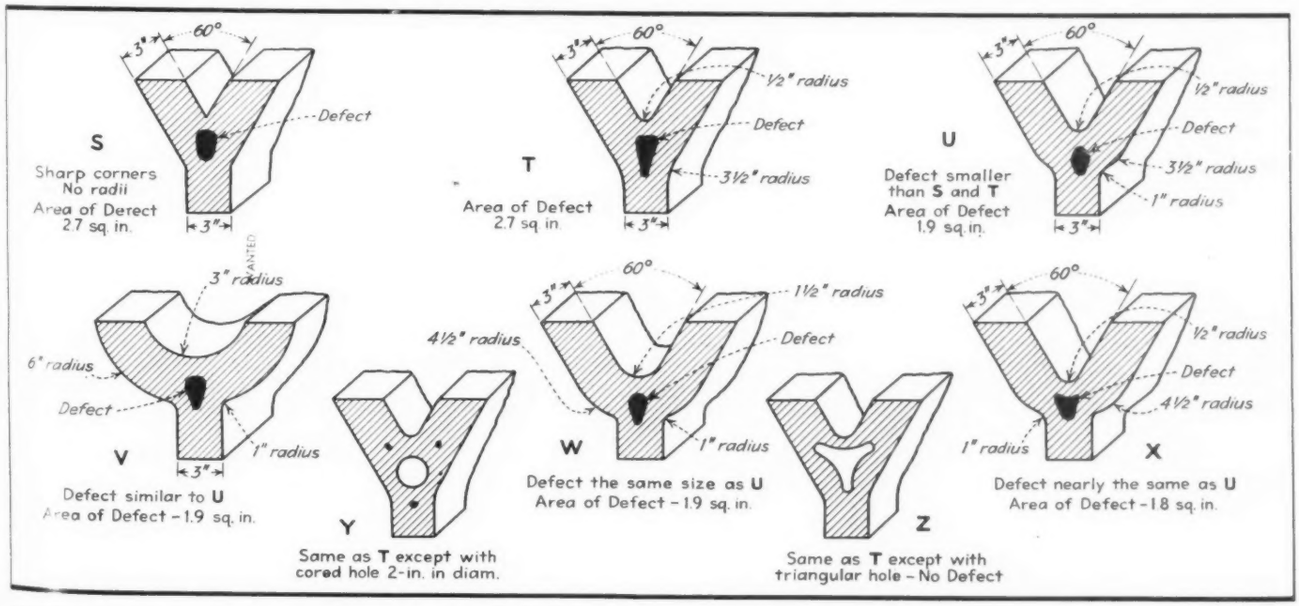
7. In designing any joining sections, it is suggested that all sharp corners at the junctions be replaced by radii. In the case of unfed "T" and "X"-sections, these radii should not be large.

8. In a general way, it may be said that the effect on the mechanical properties because of increasing mass is not pronounced and probably is amply covered by factors of safety.

Material published by permission of the Navy Department, was first published in the May 1938 issue of the Journal of the American Society of Naval Engineers. *Authors: C. W. Briggs, R. A. Gezelius and A. R. Donaldson. Illustrations courtesy of Steel Founders' Society of America.*



Vee sections having sharp corners will not be free from contraction cavities, a hot spot will develop at the junction because the sand is not able to conduct heat away from the three inside faces as fast as the sand can conduct heat away from the single outside face. It will be noticed that if the inner radius is increased that the defect will be smaller than in a comparable section such as *N*. As with the "L" design, a slightly reduced section at the junction of the members is necessary for a homogeneous section. In designing "V" sections, it is suggested that an inner radius not less than 1 in. be used.



"Y"-sections. It was found that no matter how the features of the design were altered the defect was about the same size. The only design without defect is Z. A triangular hole of this type is able to extend to all the hot spots that are possible in the section. Occasionally, there appears a design wherein an area of heavy metal is attached on all sides to members of much smaller thickness and so located that the foundryman has no opportunity to properly feed the heavy portion by means of a conveniently placed feed reservoir. Such a condition is distinctly one of poor design. The heavy section should be either cored or more closely investigated to ascertain if it could not be made lighter.

News

Machine Tool Designers Emphasize Motor Appearance and Simple Controls

Annual Westinghouse Forum attracts record attendance of engineers from leading tool builders to discuss electrification problems

MORE THAN 80 engineers, representing leading builders of machine tools gathered at the Westinghouse Electric & Manufacturing Company in East Pittsburgh, April 18-20, to attend the fourth Annual Machine Tool Electrification Forum. The keynote of the meeting was sounded by Wendell E. Whipp, President of the National Machine Tool Builders Association, in his paper, "Motors and Machine Tools."

"In keeping with the better appearance of our modern machine tools, we want better finish on motors, and notwithstanding the additional cost of that operation, I am satisfied that you will soon find it desirable to do so," said Mr. Whipp, who is also president of the Monarch Machine Tool Company. In amplifying this statement Mr. Whipp pointed out that whereas chromium-plated trim adds nothing to the service values of an automobile, it gives the purchaser a better appreciation of the high quality of the car. Likewise a better finish on an electric motor will give purchasers a better appreciation of the high quality of the motor.

Referring to the report by the Committee on Electrical Problems of the Machine Tool Builders Association, Mr. Whipp said that it clearly indicated the need for study on the part of machine tool designers of the possibilities of better motor and control applications and a better understanding of the materials that the electrical manufacturer already has to offer.

In discussing Mr. Whipp's paper, Tell Berna, general manager of the National Machine Tool Builders Association, explained the work being done by the committee in developing machine tool wiring standards to meet the National Electric Code as is or as modified.

Paper on Style Introduced

Whereas the three previous annual forums sponsored by Westinghouse confined the program to papers on electrification problems, this year a paper on appearance was included and received a great deal of favorable comment. Under the title, "The Styling of Special Machinery," Herbert Rosengren, design consultant for the American Machine & Foundry Company showed how the bread slicing and bread wrapping machines manufactured by that company were restyled.

In the discussion following Mr. Rosengren's paper, Mr. R. S. Elberty, electrical engineer of the Landis Tool Company, mentioned the principles of dynamic symmetry as applied to appearance design. This mathematical-geometrical method of proportioning is not generally followed, it appears.

A brief paper, "Reduce the Cost of Electric Drives," by W. E. Happel and R. S. Elberty, both of Landis Tool Company, gave some striking figures on cost reduction through simplified electric control. In one instance a new control system not only simplified the wiring but also permitted the elimination of several control relays, resulting in a saving of $134 per machine in electrical and $50 in mechanical equipment.

Many highly interesting points were brought out in the discussions following the various papers. M. E. Lange, chief engineer of Warner & Swasey, told about provisions made to prevent heat from the motor causing certain parts of the driven machine to expand and thus cause distortion. W. H. Leak, chief electrician, called attention to the fact that in some cases the electrical equipment is placed in such an accessable position that it must be removed to get at other machine parts requiring more frequent attention. R. H. Anderson, electrical engineer of the Singer Manufacturing Company, reported that in his company's experience harm was often done when anti-friction bearings were taken out for inspection. Usually dirt got into them. It was also suggested that grease pipes extending from the bearing housing to the outside of the machine should not be provided, as this has often resulted in the bearings getting too much grease.

In his paper, "The Flexibility of Modern Electric Drives," George E. Hieber, chief engineer of the Cincinnati Planer Company, listed and illustrated six distinct advantages in individual motor drives as applied to a planer type milling machine: (1) Each spindle can be run independently; (2) Each spindle can be run at its own speed; (3) Either

Design engineers of prominent tool builders in session at East Pittsburgh at the 1939 Machine Tool Electrification Forum

spindle can run in either direction; (4) The spindles can be made to swivel; (5) The spindles have independent speed ranges; (6) The spindles cannot be overloaded.

Other papers presented included: "Gearmotors to Simplify Design Problems," C. B. Connell, application engineer, Gearing Division, Westinghouse; "Welded Fabrication As An Aid to Electrification of Machine Tools," W. A. Maddox, welding supervisor, Cincinnati Milling Machine Company; "A Study of Reversing Motor Duty," R. E. Toomey, Industrial Motor Engineering and T. R. Lawson, Motor and Generator Section, Motor Division Sales, Westinghouse; "Small Motors in Machine Tool Applications," L. R. Botsai, sales manager, Small Motor Division, Westinghouse; "Selecting Motors for Machine Tools," W. F. Ridgway, development engineer, Ingersoll Milling Machine Company; "Progress in Electrification of Large Machine Tools," G. A. Spohn, electrical engineer, General Machinery Corporation; "Why Buy New Machine Tools?," J. R. Weaver, director of equipment, inspection and test, Westinghouse; "Adventures in Electricity," Dr. Phillips Thomas.

University Research Aids Small Industry

SMALL INDUSTRIES "must look to the states and mainly to state-supported institutions of higher education for help in research," said Dr. Robert L. Sackett, Dean Emeritus of Engineering of the Pennsylvania State College, in a paper presented at the Research Day meeting of the State of Connecticut, held May 18 at Hartford. "Not much of the federal budget is devoted directly or indirectly to solving the problems of the small industry," continued Dr. Sackett, in pointing out that of the $21,000,000 spent by the federal government by research in 1938, the only production part was $3,700,000, or 17.6 per cent, allotted to the Bureau of Mines, the TVA, agricultural engineering, good roads, and air commerce research.

Large industries, able to support extensive research programs, have long been demonstrating the spectacular results of scientific search and application of engineering to the development of new products. Small industries, alone or by collective effort through associations, can obtain the benefits of well-equipped research laboratories by using college and university facilities. That the research activities of American institutions is of considerable importance is shown by the fact that a total of $51,000,000 was spent in one recent year by educational laboratories in the search for new sources and methods of producing wealth for industry.

"University research plays a triple part in the support of American industry," stated Dr. Sackett. "In the first place, it adds to the store of new knowledge; in the second place, it helps to apply that knowledge to useful purposes; and in the third place, it prepares those of special talent to take their places in commercial and governmental laboratories to carry on research and development."

Substitute for Mica Made from Clay

"ALSIFILM," a new type of transparent film material made from clay, can be used as a mica substitute, as an indestructible paper, as a fireproof wrapping material and as a waterproof coating for paper articles, according to a recent report by Dr. Ernst A. Hauser before the Technical Association of the Pulp and Paper Industry. The new material, as described in the *Industrial Bulletin* of Arthur D. Little, Inc., is made from an especially pure type of bentonite, and may be made so thick that it is stiff and brittle, giving the appearance of and electrical properties similar to mica. Both mica and Alsifilm are composed of alumina, silica and water.

It is claimed that the new film can be made completely inert to oils, greases, organic solvents, and strong acids and salts. In the thin, flexible film form it would offer long life and the needed electrical properties for cable-wrapping. Foods, especially those which readily take up

As fast as its streamlined appearance indicates—one of the three 500-ton single-acting hydraulic presses recently shipped from the Eddystone shops of the Baldwin-Southwark Corporation to an automobile manufacturer. Self-contained and oil operated, the press has a platen 48 in. by 41 in., with a full stroke of 20 in. Pump, motor, and valves, located in the top of the press, are readily accessible

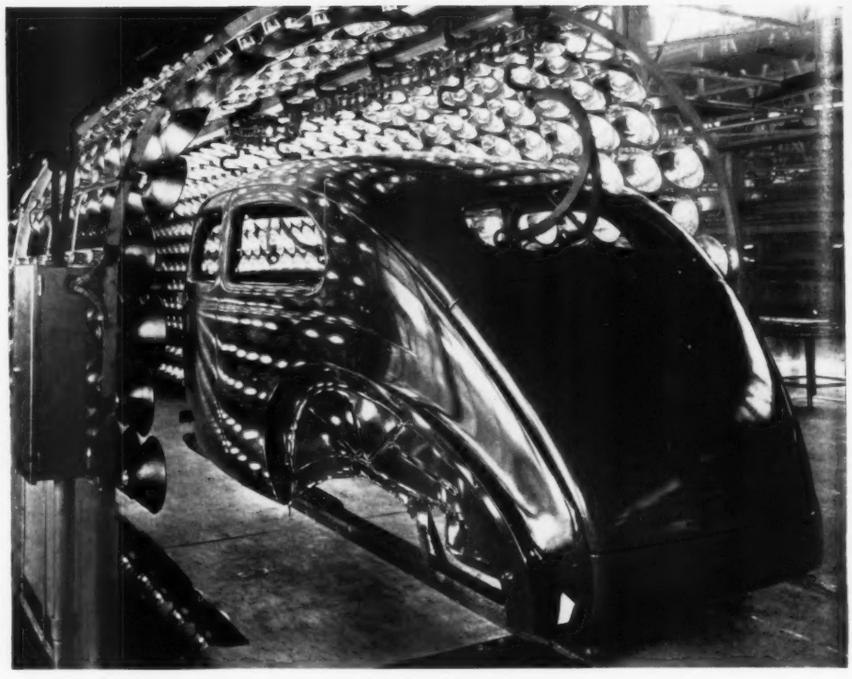
odors and tastes, might be packaged in this inorganic transparent film. Ordinary printing and coloring processes can be used with Alsifilm. Unaffected by climate, mold, or insects, it has possibilities for use as a permanent record material, handled as easily as any paper.

Alsifilm is to be introduced commercially by the Research Corporation for the Massachusetts Institute of Technology and Dr. Hauser. At the present stage of development none of the material is available for distribution.

A. H. Compton Predicts Era of Atomic Power

"APPARENTLY we are now closer to the realization of atomic power than at any time in the past," said Professor Arthur H. Compton, Nobel prize winner and professor of physics of the University of Chicago, at a meeting of the American Association for the Advance of Science, held May 4, at Alpine, Tex., in connection with the opening of the new McDonald Observatory. "Recent developments have made scientists both enthusiastic and fearful, but we have not yet bridged the gap between the atom and the power house."

Pointing out that there is a very large and constantly increasing demand for power which will reach greater magnitude than can be practically supplied by present methods, he stated that this demand will in all probability be met by science with the development of atomic power. Professor Compton went on to review the rapid advances recently made in American and European laboratories. Physicists are now concentrating on the study of the tremendous energy released by the splitting up of an atom of actinouranium, an isotope constituting one-tenth of one per cent of the ordinary uranium found abundantly in various parts of the world.



Baking enamel from the inside out—infra-red rays, reflected with slight loss from thousands of these gold-plated reflectors arranged in 90 ft. tunnel sections, penetrate the synthetic resin enamel on Ford car bodies and heat the metal underneath. New method requires 15 min. Former steam oven baking took one hour

MEETINGS

SOCIETY OF AUTOMOTIVE ENGINEERS—*World Automotive Engineering Congress, Hotel Statler, Detroit, May 31–June 8; Hotel Fairmont, San Francisco, June 6–8. John A. C. Warner, secretary, 29 W. 39th St., N. Y.*

AMERICAN ELECTRO-PLATERS' SOCIETY—*International convention, Asbury Park, N. J., June 19–22. W. J. R. Kennedy, executive secretary, 90 Maynard St., Springfield, Mass.*

STEVENS INSTITUTE—*Ninth annual Economics Conference of Engineers, Stevens Engineering Camp, Johnsonburg, N. J., June 24–July 3. James Creese, vice president, Stevens Institute of Technology, Hoboken, N. J.*

AMERICAN SOCIETY FOR TESTING MATERIALS—*Annual meeting and exposition, Chalfonte-Haddon Hall, Atlantic City, N. J., June 26–30. R. E. Hess, assistant secretary, 260 S. Broad St., Phila., Pa.*

AMERICAN SOCIETY OF MECHANICAL ENGINEERS—*Semi-annual meeting, San Francisco, July 10–15. C. E. Davies, secretary, 29 W. 39th St., N. Y.*

A.S.T.M. to Discuss Temperature Effects

A ROUND-TABLE discussion on the Effect of Subatmospheric Temperatures on the Properties of Metals promises to be of particular interest to design engineers attending the annual meeting of the American Society for Testing Materials, to be held at Chalfonte-Haddon Hall, Atlantic City, N. J., June 26 to 30. Recognizing a growing demand in many industries for materials having properties suitable for use at low temperatures, the Society is sponsoring this round-table discussion as a means for gathering together all the available knowledge on the subject.

Among many other important technical features of the meeting are discussions on paint testing, quantitative spectrochemical analysis, and fatigue of metals. The A.S.T.M. exhibit of testing apparatus and related equipment, with displays sponsored by a number of leading companies in the instrument and similar fields, will be in progress throughout the five days of the meeting.

Do You Know That—

NICKEL SILVER as it is known today, traces its history in an unbroken line from the Chinese alloy, paktong, of 2000 years ago. (12)

ABRASIVE CUTTING saves $.01 per lb. in the cutting of un-annealed, corrosion-resisting valve stock. Formerly this material was purchased annealed for cutting. (13)

A METHOD OF PLATING steels with nickel up to twenty times usual thickness is claimed to give a coating free of porosity. Developed originally for use in oil fields, it has possibilities for giving low-cost materials high corrosion-resistance. Coating is claimed to be malleable enough to resist abrasion. (14)

A NEW NON-SKID paint for use on stair treads, concrete floors, steel floor plates is made up of stainless steel flakes in a varnish vehicle. (15)

A MINIATURE MAGNET of Alnico, weighing 1.85 grams, will lift nearly 1500 times its own weight. A steel sheath around the Alnico Pellet directs the magnetic flux against the object being attracted. The sheath also protects the magnet against demagnetization when not in use. (16)

A NEW MACHINABLE ceramic material, available in round, tubular, disk, and plate forms, can be turned on a lathe or milled like steel and has good dielectric and mechanical properties. (17)

New Materials and Parts

Heavy Duty Engines

Complete new line of ruggedly constructed single, two and four cylinder, radiator-cooled engines are designed for heavy-duty service. These power units are completely equipped with extra large anti-friction bearings, with tapered roller bearings in the end position to carry any thrust load. Heavy flywheels give smooth operation at all speeds and under varying load conditions. Proper lubrication is assured by positively driven gear oilers, and large oil and gasoline capacities allow for long periods of operation without attention from the operator. Equipped with heavy-duty, Twin-Disk clutches, these engines conform to all S.A.E. standards including accessories as: electric starter and generating equipment; water circulating pump; fuel pump; lubricating oil pump and filter; combination carburetor for gaseous fuels and gasoline; and kerosene burning attachment. Available in sizes from 2 to 22 hp. and are known as the Model "CW" engines. Novo Engine Co., Lansing, Mich.

Refrigeration Controls

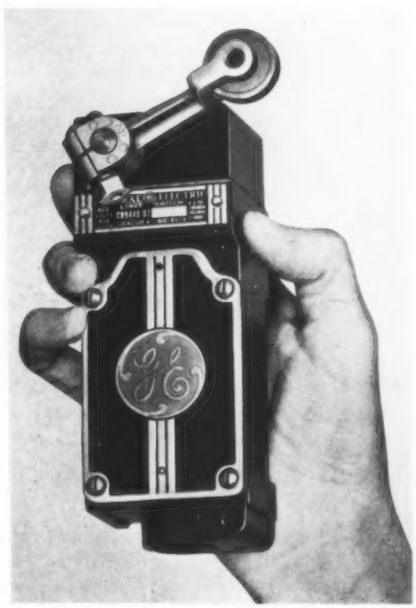
New line of refrigeration temperature and pressure controls use solid liquid charges to actuate the switch contact so powerfully that extremely high loads can be carried without relays. The sensitive element is a metal bulb filled with liquid from which all gases have been excluded, connected to a single diaphragm for direct transmission of movement to the switch. Positive snap action and positive contact makes these controls immune to any normal vibration or "off-level" installation. Contacts are of silver. The switch is entirely inclosed to prevent entrance of dirt or obstruction from misplaced leads. Available for temperature ranges from —20 deg. to +75 deg. F. Julien P. Friez & Sons, Baltimore, Md.

Signal-Graph Timer

Improved instrument for timing industrial processes is controlled by an electric switch and may be located any distance from the machine. Operated by a synchronous motor, the instrument automatically signals the operator when the processing period has elapsed. At the same time it automatically records on a chart calibrated in minutes, the processing time of each operation, as well as the loading or inactive time. Production Instrument Co., 702-10 W. Jackson Blvd., Chicago, Ill.

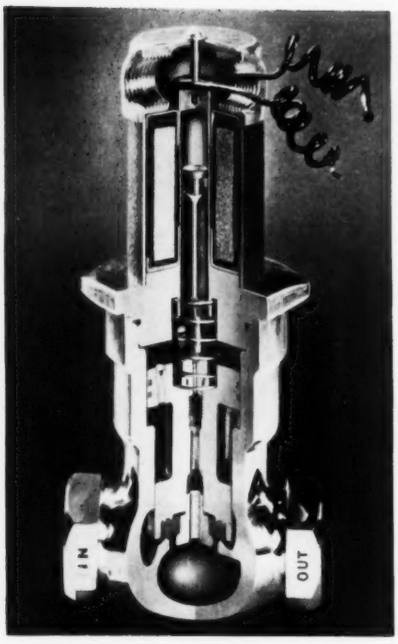
Small Limit Switch

Designed for use on machine tools, conveyors and other automatic equipment, a small snap-action limit switch has the advantage of being so constructed that it can be easily mounted in practically any position. It operates slowly without contact burning and is proof against oil and dirt. Silver-to-silver double-break contacts assure long life while two independent circuits provide any contact arrangement. Positive snap-action is obtained by means of an over-center toggle mechanism. Supplied with either a roller-lever or push-rod head. General Electric Company, Schenectady, N. Y.



Atkomatic Valve

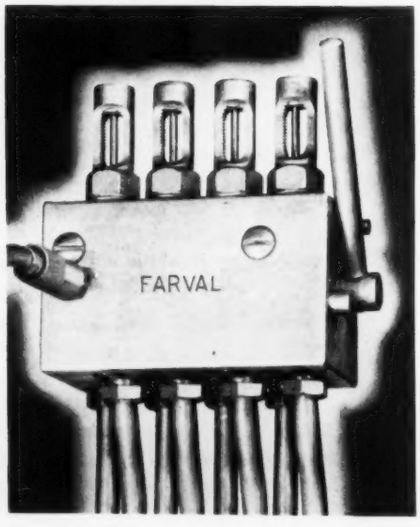
Electrically operated valve, particularly adaptable for difficult, continuous operation on steam, and general application on automatic or remote control of liquid or gases, uses line pressure as



the main actuating force. Known as the Atkomatic Valve, it has only three moving parts, no weights, levers or packing. Non-metallic valve disks insure maximum wear and tight seating. Parts are of bronze and stainless steel. Low current consumption is claimed. Full flow from $^3/_8$ in. to 3 in. pipe sizes on pressures up to 300 lb. per sq.in. Maximum steam pressure 150 lb. per sq.in. E. C. Atkins & Co., 402 S. Illinois St. Indianapolis, Ind.

Lubricating System

A new system for lubricating small machines or a few bearings on larger machines from a single grease inlet consists of a multiple measuring valve block with from 2 to 8 lubricant outlets per block. As many valve blocks as are necessary can be installed and connected in series. The positive lubrication



of every bearing regardless of position is accomplished by connecting a conventional type of grease gun to the grease nipple at the inlet port. Movement of the indicator stem attached to each valve piston shows when each bearing has received its measured amount of lubricant. The amount delivered to any pair of outlets is adjustable. Block contains no check valves and no springs, and is extremely simple in design and construction. Farval Corp., Cleveland, Ohio.

Dial Thermometer

Ruggedly constructed for long, dependable and accurate service, the Wheelco Dial-Indicating Thermometer is inclosed in a cast case with 6-in. dial face. Of the Bourdon tube type, the

thermometer is made with mercury, gas-filled, or vapor actuations, and can be applied to temperature ranges from 0 deg. F. to 1,000 deg. F. Available in the long-distance type for installation at some distance from the point of temperature taking, or in the stem type for location at the point of temperature taking. Wheelco Instruments Co., 1929-1933 So. Halsted St., Chicago, Ill.

Potentiometer

In the new vibration-proof indicating potentiometer, Celectray Model V, a damped photoelectric circuit, has been developed which does not respond to abnormal disturbance of the light-beam reflected from the mirror of a moving galvanometer. The controller, which is claimed to be sensitive to temperature change but not to vibration, can be

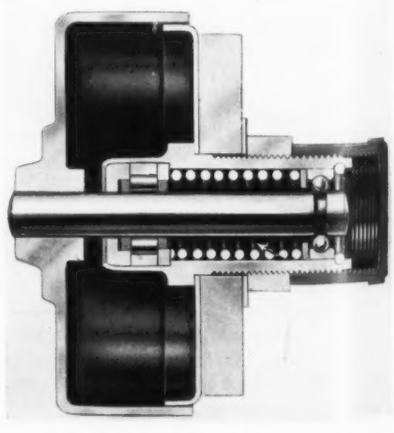
mounted rigidly on a vibrating panel along with the contactor without regard for the possible effect of vibration. Features include safety shut-off, 15-in. scale, 0.1 per cent accuracy, and high visibility. C. J. Tagliabue Mfg. Co., Park and Nostrand Aves., Brooklyn, N. Y.

Duotone Baked Finish

For use on various metals, Duotone, a new baking metal finishing material, produces a uniform two-tone effect in one spray application. Easy to apply, unaffected by varying oven conditions, and producing a consistently uniform finish, Duotone is claimed to give a coverage per gallon greater than other types of finishes designed for the same purpose. Available in a wide variety of colors. The Glidden Co., Cleveland, Ohio.

High Speed Idler Pulley

New high-speed, free-running idler pulley, developed for use in industries having light and medium duty high speed belt drives, features a dust-proof protective cover which eliminates all types of abrasive matter from the relatively heavy-duty roller bearing and the stabilizing ball bearing. The bearings run directly on a through-hardened chrome steel shaft. Grease cups and reservoirs are large enough to provide proper lubri-



cation for two years. Pulley units, with overall lengths up to 3 15/18 in., are easily mounted. Five standards sizes of crowned pulleys are now available, and units are provided for special design. SKF Industries, Inc., Philadelphia, Pa.

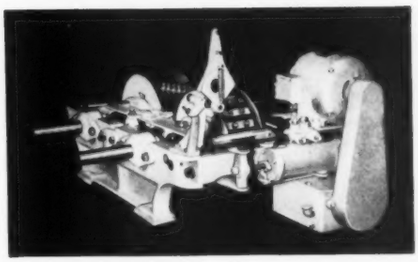
Combination Linestarter

Consisting of a magnetically operated linestarter and a manually operated motor circuit switch combined in the same streamlined cabinet, the new De-ion combination linestarter is especially designed for across-the-line starting of squirrel cage motors, or as primary switch for wound-rotor induction motors. Linestarter features the safe-locking design of door handle. The starter has fuseless

circuit protection, by an instantaneous magnetic trip circuit breaker. The breaker handle is a positive indicator, showing whether breaker is "on", "off", or "tripped". Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pennsylvania.

Automatic Speed Control

Reeves variable speed transmission with improved hydraulic automatic control is simple and compact in design, with few working parts, sensitive and positive in speed regulation. Pressure of only two or three ounces will produce change in speed. Back lash and lost motion are definitely eliminated and liquid in the oil pump acts as a brake to prevent movement when the control is in "neutral," thus preventing "coasting" and "hunting." From 6 to 20 sec. are required to shift the transmission from maximum to minimum speed and



vice versa, depending on size and ratio. Protective mechanism absorbs the shock of sudden or violent shifting. Reeves Pulley Company, Columbus, Indiana.

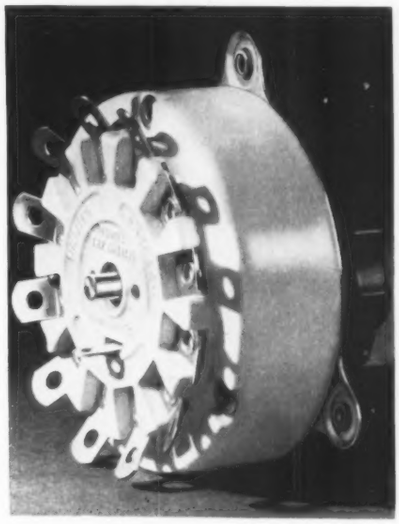
Beryllium Alloys

Heat-treated beryllium alloys in rod, strip and wire forms, are now available from the Beryllium Corp. of Pennsylvania. The company, which formerly supplied master alloys only in the ingot and cast forms, has recently completed specially designed facilities for the commercial production of 2-2.25 per cent beryllium-copper, beryllium-cobalt-copper, beryllium-chromium-copper, beryllium-nickel, and other alloys in the primary fabricated shapes under exact laboratory control of all physical properties. Beryllium alloys, with high electrical conductivities and tensile strengths, elastic stability, resistance to fatigue, heat and wear, and uniform hardening characteristics, find their greatest use in the manufacture of electrical devices, small machine parts, springs, aviation instruments, business machines, and other similar products. The Beryllium Corp. of Pennsylvania, Reading, Pa.

Angle Type Spray Nozzle

"Whirljet Angle Type" spray nozzle produces a hollow cone spray with uniform distribution in installations where it is necessary to have a non-clogging, centrifugal type nozzle with pipe connection parallel to direction of spray.

Nozzles are sturdily constructed and have large passages making them practically clog-proof. Pipe connection is $\frac{3}{8}$ in. male. Available in 6 different capacities from 0.5 to 2.5 g.p.m. at 10 lb. per sq.in. Standard in brass, other metals can be specified. Spraying Systems Co., 4922 W. Grand Ave., Chicago, Ill.



Tap Switch

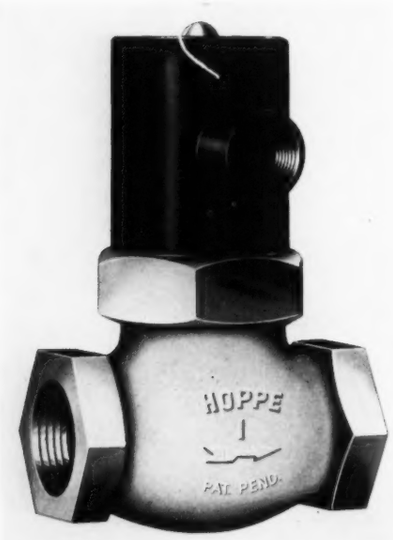
Ohmite Model 412 high amperage, heavy-duty, rotary multi-point selector tap switch is compact, and has all-porcelain construction. Important design features include: silver to silver contact, cam and roller snap-action, all-porcelain high-voltage insulation, back-of-panel mounting, designed for single or tandem mounting. The tap switch is rated for 40 amp. in 240 volt a.c. non-inductive circuit, is 4 in. in diameter, and is equipped with a maximum of 12 contacts. Ohmite Mfg. Co., 4835 Flournoy St., Chicago, Ill.

Anode Rubber Tubing

Continuous rubber tubing, made of pure latex by the Anode process, is uniform in size, wall and strength, and is perfectly smooth both inside and out. Highly resistant to age deterioration and repeated sterilization, the amber-colored tubing is sufficiently translucent to show fluid levels and has a permanent finish that is soft and silk-like. Available in 50 ft. lengths in 3 sizes only, $\frac{3}{16}$ x $\frac{1}{16}$ in., $\frac{1}{4}$ x $\frac{1}{16}$ in., and $\frac{5}{16}$ x $\frac{1}{16}$ in. Mechanical Rubber Goods Div., The B. F. Goodrich Co., Akron, Ohio.

Tight-Closing Valves

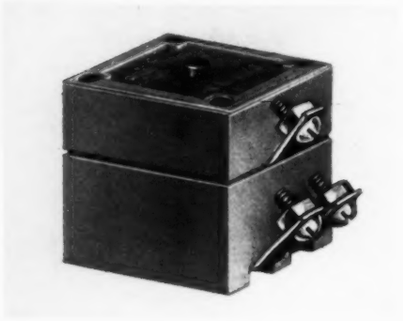
Electrically operated valve for handling freon, methyl chloride, sulphur dioxide, brine, air, oil, water, steam and ammonia, consumes only 7 watts operating at 250 lb. per sq.in., 15 watts at 400



lb. per sq.in. The 1 in. valve shown weighs only 4¼ lb. Height over all 5¾ in. Length 3¾ in. This valve is absolutely tight closing, both main valve and pilot valve having soft disks and seats. All seats and disks are standard and are renewable. Coils are impregnated to resist moisture and are designed for constant service. Available in sizes from ½ in. up to 2 in. Hoppe Engineering Company, Indianapolis, Indiana.

Sealed Switch

New H-C Sealed Switch features ceramic case which is hermetically sealed against oil, moisture and dirt, and treated so that it is impervious to the penetration of gases and resistant to



deterioration in the presence of most common substances. Can be safely operated as high as 300 deg. F. Pressure, ranging from 2½ oz. to 8 oz., and travel of the sensitive switches have been improved. Type C switches are designed for 15 amp. at 125 volts a.c. or 6-7 amp. at 220 volts a.c., based on an operating speed of 15 per min. for the maximum ratings. Available in single pole normally closed or open and single pole double throw. Allied Control Co., Inc., 227 Fulton St., New York, N. Y.

Low Temperature Enamel

A new enamel for industrial finishing, known as Low-Bake "Dulux" enamel, is claimed to speed up production in low-temperature ovens. Has the following baking schedules: One-quarter hour at 250 deg. F.; one-half hour at 225 deg. F.; two hours at 175 deg. F. The finish has demonstrated good gloss and build, print resistance, and retained flexibility. It is said to be wrinkle-proof under all normal conditions. It gives satisfactory hiding in one coat when applied on solvent-cleaned steel, bonderited steel or primed steel. White and colors are available. Finishes Division, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

"Speed-Trol" Motor

Completely automatic variable speed system is governed by the position of a small lever which travels through an arc of approximately 60 deg. for complete

speed range and is provided with overtravel to prevent damage to the switch mechanism. Pilot motor is 3-phase squirrel cage, with hardened steel worm and bronze worm wheel. All contacts in the entire system are "quick-break." Overtravel and hunting of the pilot motor has been eliminated. Units with standard gear ratios can be furnished with ratings up to 15 hp. Sterling Electric Motors, Inc., Telegraph Road at Atlantic Blvd., Los Angeles, Calif.

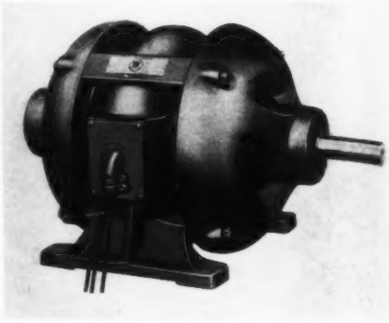
Roller-Leaf Micro Switch

Roller-leaf actuated switch is designed for service in applications requiring roller action where small moving power is available to make or break the circuit. Overall size is 2½ in. long, 1⅜ in. high and ¾ in. wide. Handles ½ hp. The leaf spring is stainless steel ribbed. Case

hardened roller is mounted on an oilless bronze bearing. This switch is of single pole construction, and can be obtained with normally opened, normally closed, or double throw contact arrangement. Micro Switch Corp., Freeport, Ill.

Lint-Free Motor

"Lint-Free" motor for use in the textile industry features specially shaped rotor vanes which circulate the air through the motor at proper velocity to remove lint, glass-smooth windings to prevent lint from clinging, extra large



air passages, and no screens to require cleaning. Open construction makes cleaning by hand or air hose easy and economical without disassembling the motor. The motor is equipped with sealed cartridge type ball bearings, with the seal for retaining the grease built into the bearing itself. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Light Weight Pillow Block

Light weight, self-aligning, Randall One-Piece Steel Housing Pillow Block consists of only three parts. To cover a range of installation requirements it can be mounted in any position. This

new precision machined bearing has increased oil capacity, and the entire assembly is cadmium plated to resist corrosion. It is interchangeable with all other pillow blocks of the line having the same shaft sizes. Available in shaft sizes from ½ in. to 1 in. Randall Graphite Products Corporation, 609 West Lake Street, Chicago, Illinois.

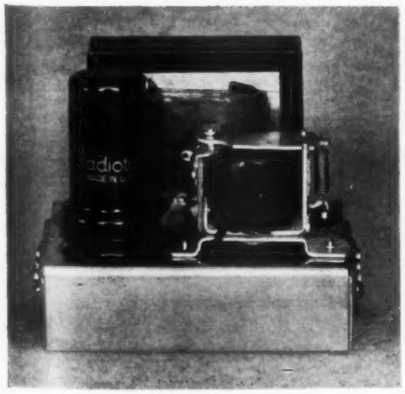
High Pressure Cylinders

New compact high pressure cylinders are of centrifugally cast high test iron machined by the same method used in boring long range guns, giving a straight, concentric, mirror finish, accurate to

size. Cylinder heads and pistons are also of high test cast iron. Pistons are fitted with "Step Seal" rings. Piston rods are of heat treated alloy steel and are "chevron" packed. All Hanna high pressure cylinders are equipped with cushions in both heads. Available in ten types with diameters ranging from 1½ in. to 8 in. for pressures up to 1,500 lb. per sq.in. Hanna Engineering Works, Chicago, Ill.

Electronic Switch

Operating with contact resistances to 500,000 ohms and a current carrying capacity of ten micro-amp., "Electronic Switch" is claimed to eliminate sticking



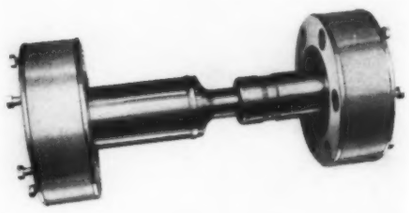
and arcing contacts on such equipment as thermostat regulators, small limit switches, or any type of equipment requiring very low contact pressure. The switch may be operated in any position and in temperatures up to 150 deg. F. United Cinephone Corp., 43-37 33rd St., Long Island City, N. Y.

Impervium Insulation

Impervium, a new insulation material made of synthetic resins, possesses many of the important characteristics of rubber, and has a high resistance to corrosive reagents, alkalies and oils. Having high dielectric values, when applied in coats as thin as 0.005 in., is an excellent insulation for plating and chemical units, for electrical units of every description, and for protection of metals against practically every corrosive reagent. Paramount Rubber Service, Inc., 1430 Rosedale Park, Detroit, Mich.

Radial Coupling Drive Shaft

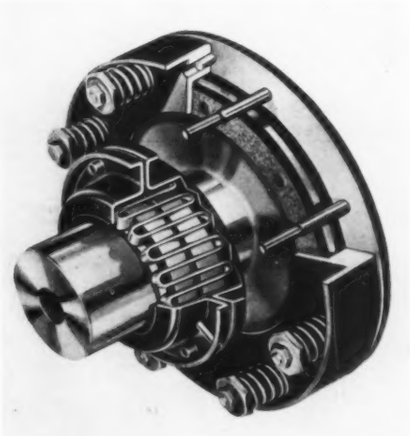
The "Morflex" radial coupling drive shaft combines the features of the standard Morflex radial coupling in a high-grade slip joint drive shaft for use as a remote drive, or where added flexibility may be necessary. The slip joint



is full spline construction, grease tight, and slides freely under load. Unit is specially adapted for use on dynamometer drives and other installations in which endwise shaft float may be encountered. Available in two types, the long coupled, where tubing is added to suit customers requirements, and the short coupled, which is made up in one standard length. Both types are made in various sizes with capacity ratings of from 2 to 27 hp. per 100 r.p.m. Morse Chain Co., Ithaca, N. Y.

Steelflex Coupling

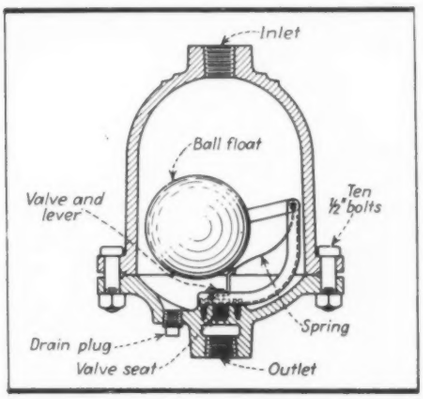
Protecting mechanical drive systems against the damage caused by shock overload, the Falk Controlled Torque Steelflex coupling consists of the combination of a Falk Steelflex coupling,



and an adjustable pressure friction clutch. The coupling damps out ordinary shocks, reduces vibration, and allows free end float. Instantaneous high peak loads cause the clutch to slip, protecting connected machinery. Available with basic ratings from 0.4 hp. to 230 hp. The Falk Corporation, Milwaukee, Wis.

Snap-Action Air Trap

"Snap-Action" mechanical trap for draining water from compressed air lines, tanks, separators, and aftercoolers, features positive opening and closing of discharge valves, rendering it immune to ordinary dirt trouble. Quick, forceful operation of the valve is caused by a spring which snaps past dead center as the ball float moves up or down with



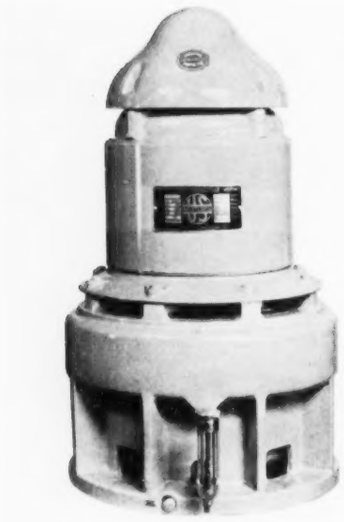
water level. The valve requires no priming. Capacity is 1,400 lb. of water per hour at 125 lb. per sq. in., and 1,000 lb. per hour at 250 lb. per sq. in. Armstrong Machine Works, 821 Maple St., Three Rivers, Mich.

Fluxed Welding Rods

"Ready-Fluxed" bronze welding rods, completely flux-coated throughout their entire length, control the even introduction of chemically correct flux throughout an entire brazing operation. Designed for application in any type of bronze welding, the new bronze rods, by making possible a continuous welding process, give a 15 per cent saving in operators' time and in gas consumption. Tests made of weld specimens show dense grain structure and high tensile strength. Compressed Industrial Gases, Inc., 221 N. La Salle St., Chicago, Ill.

Vertical Motor

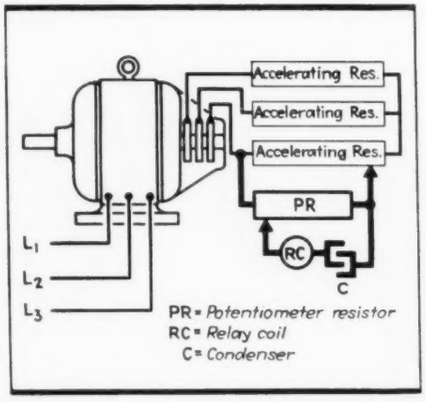
The Syncrogear Unit Type GDV, complete with flange base, is easy to mount and incorporates a small geared oil



pump which forces an ample oil supply to bearings, gears and pinions. This vertical geared head motor has a helical type gear train, and uses ball or roller bearings throughout the drive. Available in sizes from ¼ hp. to 30 hp. with shaft speeds of 4,260 to 8.3 r.p.m. U. S. Electrical Motors, Inc., Los Angeles, Cal.

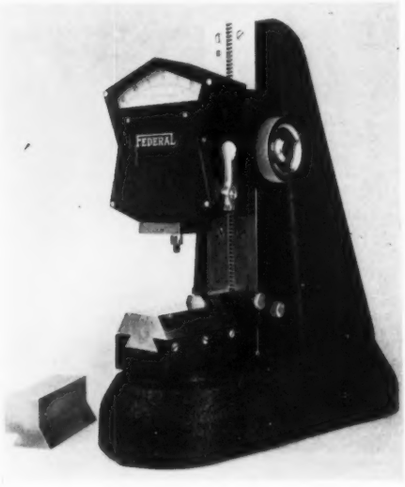
Frequency Relay Control

The new E C & M frequency relay method of control uses a simple, resonant circuit consisting of the frequency relay coil, a condenser and a potentiometer resistor, with this circuit receiving its operating voltage from the rotor circuit of an a.c. wound-rotor motor. The resonant type of circuit adjusted to a desired frequency operates the relay within small limits, providing accurate control. It makes possible the safe use of hyper-synchronous speeds with overhauling crane loads, close control of accelerating torque, and elimination of zero-speed switches in dynamic braking. The Electric Controller & Mfg. Co., Cleveland, Ohio.



Super-Sensitive Comparator

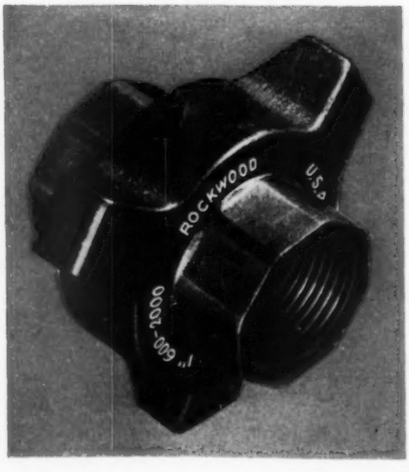
The indicator on this comparator, Model 110B-3, is especially designed to have great sensitivity and "repetition" qualities. The contact point spindle is supported by a spring bellows which eliminates friction on the spindle. Internal friction and inertia is reduced to a minimum. The lever at the side of the indicator is for fine adjustment of the contact point, after the indicator has been brought to approximate position on the vertical slide and clamped. Instrument is said to be exceptionally simple



and practical for checking other instruments, gages and any work requiring a high accuracy. Federal Products Corp., 1144 Eddy St., Providence, R. I.

Hammer Lug Union

For use where unions must be broken quickly and often, this hammer lug union has a triple lug nut for easy accessibility. Heavily constructed to withstand high pressures and severe wrench abuse. High Brinell hardness and graphitic content eliminates galling at seat joints. Made of Dualsteel, the unions are completely Parkerized as a further protection against corrosion. Rockwood Sprinkler Co., 38 Harlow St., Worcester, Mass.



Cast, Non-Ferrous Alloy For Machine Tools

Rexalloy, a new cast non-ferrous cutting alloy with basic elements of cobalt, chromium and tungsten, may be used on practically all machining operations and on all types of machine tool equipment. The hardness and the structural stability of Rexalloy at extreme temperatures is indicated by the fact that only a one point drop in hardness on the Rockwell C scale is occasioned after exposure to 2,000 deg. F. Available in tool bit form, the new alloy possesses greater resistance to abrasive wear and is tougher than cast tool material previously available. Proper grinding can be accomplished with ordinary tool room equipment. Tool cutting angles customarily applicable for high speed tool bits can be used. Standard sizes range from ¼ in. square by 2⅛ in. long to ¾ in. square by 5 in. long. Rexalloy is also available in other than standard lengths and in many square and rectangular shapes. Crucible Steel Company of America, 405 Lexington Avenue, New York, N. Y.

Frequent Reverse Motor

New line of squirrel cage motors with control will stand up under continual and frequent reversals, as high as one reversal per second, at full voltage without overheating or deterioration. Frame,

shaft, and bearings are of sturdy design. Stator windings are micabestos insulated. Rotor is a special high resistance. Stator and rotor windings are efficiently cooled with continuous forced ventilation in the form of a small auxiliary motor and squirrel cage fan at one end of the motor, which can be readily seen in the photograph. Available in a number of sizes and speeds up to 10 hp. Sterling Electric Motors, Telegraph Road at Atlantic Boulevard, Los Angeles, Calif.

Manufacturers' Publications

ABRASION TESTER—Taber Instrument Co., North Tonawanda, N. Y. Bulletin 3901, 8 x 10½ in. Sets forth details and prices of the Taber Model J Portable Abraser, a calibrated wear tester for scientific grading of surface finishes. The bulletin also describes the Taber testing service for paints, lacquers, plastics and other similar finishes.

AMERCOAT—Amercoat Sales Agency, 5905 Pacific Blvd., Huntington Park, Calif. "Amercoat on Guard Against Corrosion," 12 pages, 8½ x 11 in. Sets forth general characteristics, tests, and successful uses of Amercoatings. Includes specific information of various types of Amercoat products.

BEARINGS—New Departure Div., General Motors Corp., Bristol, Conn. New Departure Hand Book, 13th edition, 156 pages, 6 x 8½ in. Complete hand book covering dimensions, load ratings, bearing fits, and list prices of all types of New Departure ball bearings.

BONDERIZING — Parker Rust-Proof Co., Detroit, Mich. Booklet, 8¾ x 11½, 40 pages. Explains effect of bonderizing in protecting metal surface. Well illustrated booklet sets forth application methods and industrial uses. Includes results of tests made upon various types of bonderized surfaces.

CHAINS—Jeffrey Mfg. Co., Columbus, Ohio. General catalog No. 87, 960 pages, 8 x 10¾ in. The complete Jeffrey line of chains, reduction equipment, conveyors, elevators, sprockets, transmission machinery, electric vibrating feeders, screens, coolers, dryers, crushers, pulverizers, shredders, portable loaders, and stackers, are described in this catalog, with engineering data.

CONTROL INSTRUMENTS—Julien P. Friez & Sons, Baltimore, Md. Caltalog K, 24 pages, 8½ x 11 in. Features illustrations, specifications and prices of the complete Friez line of controlling, measuring and recording instruments, covering the automatic heating, refrigerating and air conditioning industries.

CUTTING ALLOY—Crucible Steel Co. of America, 405 Lexington Ave., New York, N. Y. Booklet TS400, "Rexalloy Tool Bits." An interesting booklet on this new nonferrous cast cutting alloy, now available in tool bit form. Examples of increased speeds and deeper cuts made possible with Rexalloy are shown.

FERROUS CASTINGS—Belle City Malleable Iron Company and Racine Steel Castings Company, Racine, Wis. "Ferrous Castings," four pages, 8½ x 11 in. The property and nature of the four types of ferrous castings produced by these companies and some suggestions and examples of their applications are covered in this folder.

FLEXIBLE DRIVE SHAFT—Mechanics Universal Joint Division, Borg-Warner Corp., Rockford, Ill. Catalog Ind. 1939, 12 pages, 8½ x 11 in. Gives description, illustrations, and dimensions for roller bearing universal joints and flexible drive shafts. Includes two pages of general engineering data not usually available in engineering handbooks.

FLEXIBLE SHAFT—Swartz & White Mfg. Co., 215 Washington St., Binghamton, N. Y. Catalog, 24 pages, 8½ x 11 in. Illustrates and describes complete line of flexible shaft equipment, together with the many attachments that are interchangeable with same.

HYDRAULIC CYLINDERS—Hanna Engineering Works, 1765 Elston Ave., Chicago, Ill. Catalog 229, 20 pages, 8½x11 in. Contains illustrations, dimensions, capacities and complete data for all sizes of high and low pressure hydraulic cylinders. Also includes information on control valves.

LEATHER PACKINGS—E. F. Houghton & Co., 240 W. Somerset St., Philadelphia, Pa. Bulletin, 4 pages, 8½ x 11 in. Shows how problems of design and operation are met with Vim leather packings, and lists ten "Don'ts" for packing users.

LUBRICATING SYSTEMS—Bowen Products Corp., Auburn, N. Y. Catalog No. 75, 12 pages, 8½ x 11 in. This booklet contains detailed engineering data on the Bowen Hydraulic-Automatic low and high pressure lubricating system. Installation charts and illustration of entire lubricating system are included. Catalog 76, 8 pages, 8½ x 11 in. Similar data on the Bowen Electric-Automatic lubricating system.

MOTORS—Crocker-Wheeler Electric Mfg. Co., Ampere, N. J. Bulletin 251-A, 12 pages, 8½ x 11 in. Describes alternating-current, adjustable-speed polyspeed motors. New information not given in previous bulletins includes a description of the various types of regulators available for manual, remote, or automatic speed control. A number of installations are illustrated and described.

NICKEL ALLOYS—The International Nickel Co. Inc., 67 Wall St., New York, N. Y. Bulletin T-13, 32 pages 8½ x 11 in. Nickel and nickel-base alloys and their use in the design of corrosion-resistant machinery and equipment are described in this booklet which lists tabular data and corrosion resistant characteristics. New alloys, Hastelloy *B* and Illium *R*, are included.

PAINTS—Continental Asbestos & Refining Corp., 1 Madison Ave., New York. "Quality Is Remembered Long After Price Is Forgotten," 32 pages, 8½ x 11 in. Catalog describes complete line of Carco products, including paints, floor surfaces, special cements, corrosion resistant finishes, disinfectants and cleaners.

PHOSPHOR BRONZE—The Riverside Metal Co., Riverside, N. J.. Well illustrated 48-page booklet, 8½ x 11 in., gives comprehensive story of phosphor bronze, its development, general properties and diversity of applications. The chemical composition and specifications of the various types of phosphor bronze available are also included.

STAINLESS TUBING—Carpenter Steel Co., Kenilworth, N. J. Folder includes a chart on diameter and gage sizes of Carpenter welded stainless tubing, and tabulates available analyses.

SOCKET SCREW CHART — Parker-Kalon Corp., 200 Varick St., New York, N. Y. Circular drafting room chart on socket screws. Condenses in ready reference form a large amount of data essential to users of socket screws. Window type chart also includes tabular data on set-screw point dimensions.

SPECTROPHOTOMETERS — General Electric Co., Schenectady, N. Y. "The Electrical Measurement of Color," GED-676, 18 pages, 8½ x 11 in. A technical description of the General Electrical Recording Photoelectric Spectrophotometer, its functions and applications to color analysis.

SPEED REDUCERS—Stephens-Adamson Mfg. Co., Aurora, Ill. Catalog 7838, 8 pages, 8½ x 11 in. Fully-illustrated booklet gives complete engineering information on Saco speed reducers. Drawings and complete dimensions of the units are included.

SPRING WASHERS—Spring Washer Industry, 759 Milwaukee St., Milwaukee, Wis. Monthly bulletin, 4 pages, 8½ x 11 in. Technical information on the operation and uses of spring washers, with illustrations.

STROBOSCOPES—General Radio Co., Cambridge, Mass. Bulletin, Form 420-C, 4 pages. Describes and gives specifications for Strobotac, Type 631-B, and Strobolux, Type 648-A and illustrates several industrial uses of stroboscopes.

VALVES—Central Brass Mfg. Co., 2950 East 55th St., Cleveland, Ohio. Catalog V-28, 16 pages, 6 x 9 in. Illustrations and specifications of complete line of faucets, valves and fittings for industrial purposes.

VALVES—Crane Co., 836 S. Michigan Ave., Chicago, Ill. "Service Characteristics of Globe Valves and Gate Valves." Booklet discusses and contains charts pertaining to the selection of the proper valve.

VARIABLE PITCH DRIVES—Allis-Chalmers Mfg. Co., Milwaukee, Wis. Bulletin 1261-B, 16 pages, 8½ x 11 in. Illustrates and describes the stationary control type of Varipitch Texrope sheaves for occasional speed changes. The bulletin also gives details of the motion control type for use where frequent speed changes are necessary. Dimension sheets and a variety of installation photographs are included.

VARIABLE SPEED PULLEYS—Lewellen Mfg. Co., Columbus, Ind. Catalog No. 40, 12 pages, 8½x11 in. Design data, rating tables of pulleys using Unitip double block belts and rubber belts, and dimensions for single and combination variable speed motor pulleys. Helpful suggestions in the selection of the proper pulley are given in this booklet.

WOOD PRESERVATION—Allis-Chalmers Mfg. Co., Milwaukee, Wis. "Machinery for Wood Preservation." Bulletin 1834, 32 pages, 8½ x 11 in. Well illustrated publication touches on the history, methods and processes, and economics of wood preservation. It gives numerous designs of complete plants and describes the type of machinery used. Includes tabular data on weights and measures of piling, telegraph poles, cross arms and ties.

Books and Bulletins

Plastic Working of Metals and Power Press Operations

E. V. CRANE—*Second Edition, 450 pages, 6¼ x 9¼ in. Black clothboard covers. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. Price $5.*

Based on the first edition, published in 1932, this volume clarifies and expands plastic working theory and adds practical details to the discussions of the various groups of operations. A chapter has been added to discuss the mechanical characteristics and the utility of different types of metal working presses, and an additional chapter includes an analysis of the means of combining operations in tooling automatically fed presses.

Nomograms for quick computation of shearing, drawing, ironing, coining and forging pressures, flywheel energy and similar data of use to the metal working engineer are included in the appendix, which also contains a compilation of tabular data on physical properties of frequently-used metals along with the usual numerical tables.

Welded Steel Construction

ROBERT S. HALE—*170 pages, 5⅞ x 8¾ in. Blue clothboard covers. Published by Pitman Publishing Corp., 2 West 42nd St., New York, N. Y. Price $3.*

This brief handbook covers the fundamentals of welded steel construction. Reasons for and against the use of welding; principles and definitions; design factors; applications; drawings and details; cost estimating; fabrication and inspection are covered in concise form. The book also contains six appendices: drawing symbols; reference tables and graphs; New York City's 1938 welding code; Chicago's 1938 welding code; American Welding Society specifications; and references to periodicals.

Alloy Cast Irons

Project of the Gray Iron Division of the American Foundrymen's Association—111 charts and illustrations, 75 tables, 270 pages, 6 x 9 in. Brown imitation leather covers. Published by the American Foundrymen's Association, 222 W. Adams St., Chicago, Ill. Price $3.

This volume consists of much comprehensive and authoritative information on the uses and properties of alloy cast irons. The data presented were compiled by a committee composed of representatives of alloy suppliers, alloy users, users of alloy cast iron castings, and national technical societies.

More than half of the book is devoted to subject matter covering the effects of the various alloying elements on the physical properties, machinability, electrical properties, and thermal properties of gray, white and chilled cast irons.

Of special interest to design engineers is the nineteen-page table of specific applications of alloy cast irons with compositions and physical properties. A twenty-five page bibliography is also included for those desiring more information on the subjects covered.

Arc Welding in Design, Manufacture and Construction

1,408 pages, 6 x 9 in. Semi-flexible maroon covers. Published by the James F. Lincoln Arc Welding Foundation, Cleveland Ohio. Price $1.50 in U.S.A., $2 elsewhere.

This volume contains 109 papers awarded prizes in the $200,000 Lincoln Foundation competition held in 1938. With few exceptions, the papers are reproduced in complete form. Twenty-nine of the papers are on machinery. The book is divided into ten general sections: automotive, aircraft, railroad, watercraft, structural, furniture, welderies, containers, machinery, jigs and fixtures. Providing a large volume of data on welding and welding methods, this volume should be of value to designers, architects and production engineers.

Industrial Electricity Direct-Current Practice

WILLIAM H. TIMBIE—*635 pages, 5½ x 8½ in. Clothboard covers. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. Price $3.*

In this second edition of the text book the subject matter on direct-current practice has been brought up-to-date. In the first chapter, which deals with fundamental ideas, there is now included a brief discussion of the modern concept of matter and of the electron theory. The general scope of the text, however, has not been altered.

The text covers distributing systems, power and energy, electrical properties of wires, methods of measuring resistance, magnets and magnetism, magnetic circuits, inductance, generators, motors, efficiency, armature windings, batteries and electro-chemical action, Kirchhoff's laws, insulators, dielectrics, condensers, and electrical measuring instruments.

Typical examples and practical problems based on engineering data are included to supplement the text in order to illustrate the principles developed.

Proceedings of the A.S.T.M.

PART I—VOLUME 38. *1,388 pages, 6x9 in. Clothboard covers. Published by the American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa.*

Summary of proceedings of the 41st annual meeting of the American Society for Testing Materials held in Atlantic City, N. J., June 27–July 1, 1938. Committee reports, new A.S.T.M. tentative standards and tentative revisions of standards are included.

PART II—VOLUME 38. *674 pages, 6x9 in. Clothboard covers. Published by the American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa.*

Summary of proceedings of the Rochester Regional Meeting, March 9, 1938. The volume also contains all of the papers and discussions of the papers presented at the 41st annual meeting of the American Society for Testing Materials, held in Atlantic City, N. J., June 27–July 1, 1938.

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Rubber as an Engineering Material

25 pages, 8½ x 11 in. Gray clothboard covers. Published by the B. F. GOODRICH CO., *Akron, Ohio. Price 50 cents.*

Prepared as a handbook for those who are dealing with materials and designing products, this well-illustrated book discusses the forms and properties of rubber. Much attention is paid to the resistance of rubber to corrosion, abrasion and cutting, heat, and oils and solvents. Several tables list the required conditions for use of rubber in contact with specific reagents. The elasticity of rubber and its use in vibration, shock and noise isolation is covered in detail. One chapter is devoted to the properties and uses of elastic synthetics.

Index to A.S.T.M. Standards and Tentative Standards

140 pages, 6x9 in. Published by the AMERICAN SOCIETY FOR TESTING MATERIALS, *260 S. Broad St., Philadelphia, Pa.*

The 1939 annual index to the A.S.T.M. Standards and Tentative Standards, including a list of A.S.T.M. designations in numeric sequence.

Multi-Speed Motors—II

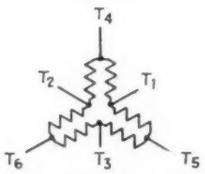
Standard Winding Connection Diagrams

W. S. RIGBY
Engineering Department, Wagner Electric Corporation

MULTI-SPEED KEY diagrams for old and new standards are shown on this page for single-winding and two-winding three phase constant torque motors with winding connections for two, three and four speeds. Similar diagrams for variable torque motors are shown on the next page.

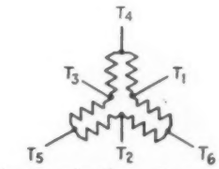
Winding connection diagrams for constant horsepower multi-speed motors were shown on pages 223 and 224 of the May *P.E.* number. For a discussion of types, characteristics and speeds obtainable in multi-speed polyphase squirrel-cage induction motors see article "Multi-Speed Motors—Speeds Available, Characteristics and Classifications," on pages 200-202 of the May *P.E.* number.

MULTI-SPEED MOTORS, CONSTANT TORQUE, KEY DIAGRAMS



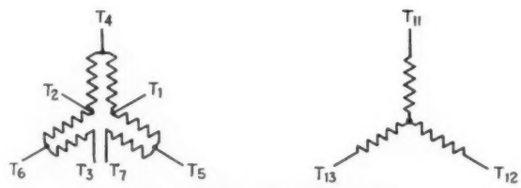
Single winding-Two speed
N.E.M.A. MG 6-41 Fig.7, 1930

Speed	L_1	L_2	L_3	
Low	T_1	T_2	T_3	$T_4\ T_5\ T_6$ Open
High	T_4	T_5	T_6	$T_1\ T_2\ T_3$ Together



Single winding-Two speed
A.S.A. C-6 3.720 1938

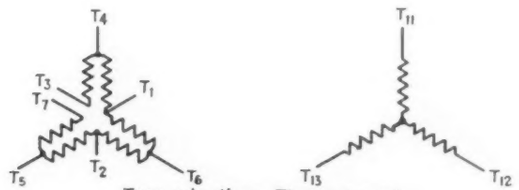
Speed	L_1	L_2	L_3	
Low	T_1	T_2	T_3	$T_4\ T_5\ T_6$ Open
High	T_4	T_5	T_6	$T_1\ T_2\ T_3$ Together



Two winding-Three speed
N.E.M.A. MG6-41 Fig.7, 1930

	Speed	L_1	L_2	L_3	
*	Low	T_1	T_2	T_3T_7	
**	Second	T_{11}	T_{12}	T_{13}	
*	High	T_4	T_5	T_6	$T_1\ T_2\ T_3\ T_7$ Together

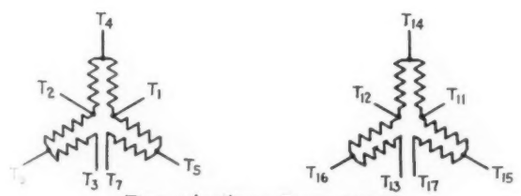
Terminals not listed must be left open
**Second speed between low and high



Two winding-Three speed
A.S.A. C-6 3.720 1938

	Speed	L_1	L_2	L_3	
*	Low	T_1	T_2	T_3T_7	
**	Second	T_{11}	T_{12}	T_{13}	
*	High	T_4	T_5	T_6	$T_1\ T_2\ T_3\ T_7$ Together

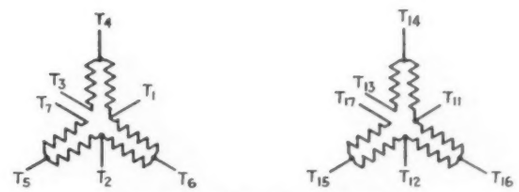
Terminals not listed must be left open
* Low speed half of high speed



Two winding-Four speed
N.E.M.A. MG6-41 Fig.7, 1930

Speed	L_1	L_2	L_3	Together
Low	T_1	T_2	T_3T_7	None
Second	T_{11}	T_{12}	$T_{13}T_{17}$	None
Third	T_4	T_5	T_6	$T_1\ T_2\ T_3\ T_7$
High	T_{14}	T_{15}	T_{16}	$T_{11}\ T_{12}\ T_{13}\ T_{17}$

Terminals not listed must be left oper



Two winding-Four speed
A.S.A. C-6 3.720 1938

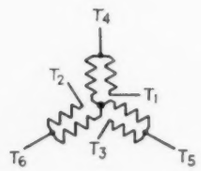
Speed	L_1	L_2	L_3	
Low	T_1	T_2	T_3T_7	
Second	T_{11}	T_{12}	$T_{13}T_{17}$	
Third	T_4	T_5	T_6	$T_1\ T_2\ T_3\ T_7$ Together
High	T_{14}	T_{15}	T_{16}	$T_{11}\ T_{12}\ T_{13}\ T_{17}$ Together

Terminals not listed must be left open

MULTI-SPEED MOTORS—

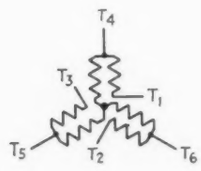
Standard Winding Connection Diagrams

MULTI-SPEED MOTORS, VARIABLE TORQUE, KEY DIAGRAMS



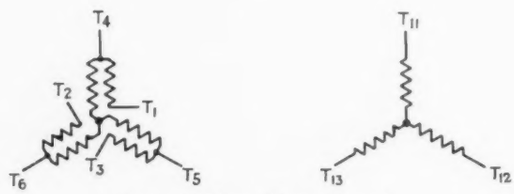
Single winding-Two speed
N.E.M.A. MG6-41 Fig.4, 1930

Speed	L_1	L_2	L_3	
Low	T_1	T_2	T_3	T_4 T_5 T_6 Open
High	T_4	T_5	T_6	T_1 T_2 T_3 Together



Single winding-Two speed
A.S.A. C-6 3.720 1938

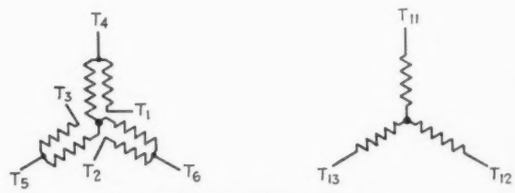
Speed	L_1	L_2	L_3	
Low	T_1	T_2	T_3	T_4 T_5 T_6 Open
High	T_4	T_5	T_6	T_1 T_2 T_3 Together



Two winding-Three speed
N.E.M.A. MG6-41 Fig.4, 1930

	Speed	L_1	L_2	L_3	
*	Low	T_1	T_2	T_3	
**	Second	T_{11}	T_{12}	T_{13}	
*	High	T_4	T_5	T_6	T_1 T_2 T_3 Together

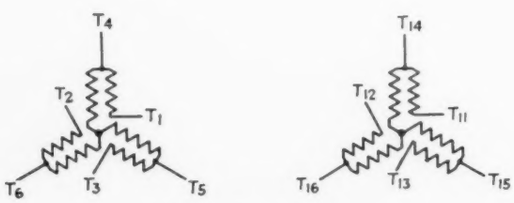
Terminals not listed must be left open
** Second speed between low and high
* Low speed half of high speed



Two winding-Three speed
A.S.A. C-6 3.720 1938

	Speed	L_1	L_2	L_3	
*	Low	T_1	T_2	T_3	
**	Second	T_{11}	T_{12}	T_{13}	
*	High	T_4	T_5	T_6	T_1 T_2 T_3 Together

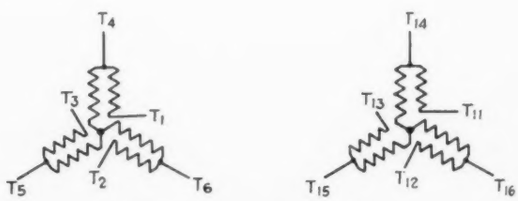
Terminals not listed must be left open
** Second speed between low and high
* Low speed half of high speed



Two winding-Four speed
N.E.M.A. MG6-41 Fig.4, 1930

Speed	L_1	L_2	L_3	Together
Low	T_1	T_2	T_3	None
Second	T_{11}	T_{12}	T_{13}	None
Third	T_4	T_5	T_6	T_1 T_2 T_3
High	T_{14}	T_{15}	T_{16}	T_{11} T_{12} T_{13}

Terminals not listed must be left open



Two winding-Four speed
A.S.A. C-6 3.720 1938

Speed	L_1	L_2	L_3	
Low	T_1	T_2	T_3	
Second	T_{11}	T_{12}	T_{13}	
Third	T_4	T_5	T_6	T_1 T_2 T_3 Together
High	T_{14}	T_{15}	T_{16}	T_{11} T_{12} T_{13} Together

Terminals not listed must be left open